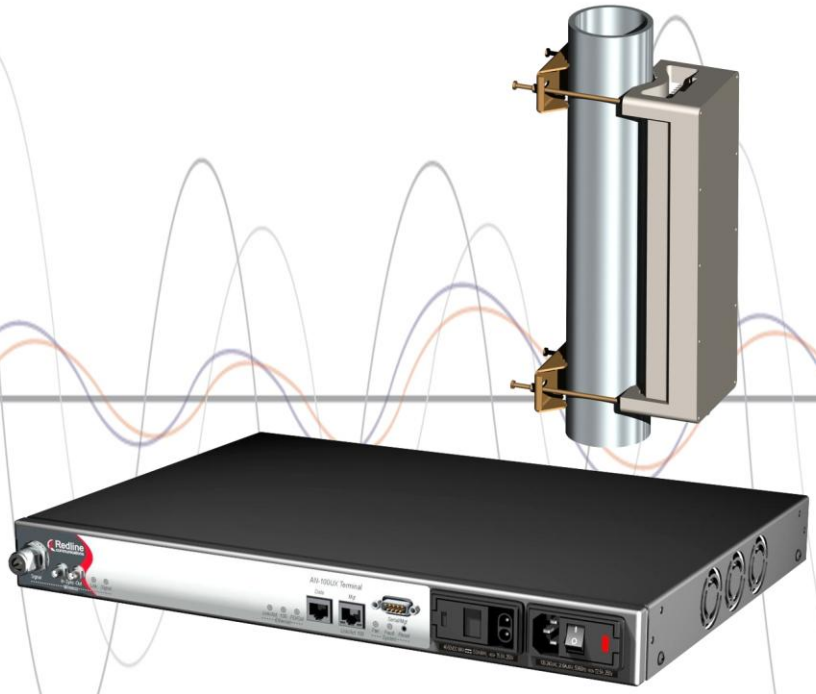
redline communications

AN-100U & AN-100UX

RedMAX™ Macro Base Stations



User Manual

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Software Versions

This user manual describes operation using software release v2.3x and may include references or features that are different or unavailable in previous software releases (refer to product release notes).

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1

1 Important Safety & Service Notices

1.1 Important Warning Symbols

The following symbols may be encountered during installation or troubleshooting. These warning symbols mean danger. Bodily injury may result if you are not aware of the safety hazards involved in working with electrical equipment and radio transmitters. Familiarize yourself with standard safety practices before continuing.

Electro-Magnetic Radiation

High Voltage

1.2 IC RF Exposure Warnings

To satisfy IC RF exposure requirements for RF transmitting devices, the following distances should be maintained between the antenna of this device and persons during device operation:

Table 1: Notices - IC RF Recommended Safe Separation Distances

Equipment	Separation Distance
AN-100U	50 cm (~ 20 in) or more
AN-100UX	135 cm (~ 53 in) or more

To ensure compliance, operation at closer than these distances is not recommended. The antenna used for this transmitter must not be collocated in conjunction with any other antenna or transmitter.

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1.3 Safety Warnings

1. Read the User Manual and follow all operating and safety instructions.
2. Installation of the antenna and modem must be contracted to a professional installer.
3. This equipments must be installed in compliance with relevant articles in National Electric Code-NEC (and equiv. Canadian Electrical Code CEC) including chapter 8.
4. The system must be properly grounded to protect against power surges and accumulated static electricity. It is the user's responsibility to install this device in accordance with the local electrical codes: correct installation procedures for grounding of the modem, mast, lead-in wire and line protection, location of line protection, size of grounding conductors and connection requirements for grounding electrodes.
5. The outdoor radio modem units must not be located near power lines or other electrical power circuits.
6. The indoor unit DC input source must be an isolated secondary DC SELV supply (60V DC max).
7. The indoor unit is supplied with a grounding power plug. Do not defeat this important safety feature.
8. The indoor unit power requirements are indicated on the product-marking label. Do not exceed the described limits and do not overload wall outlets.
9. Position the indoor unit power cord to avoid possible damage.
10. Indoor unit DC power supply connection warning:

DC Power Supply Connections: ***Warning to Service Personnel***	
Caution for all AC and DC models:	Double pole/neutral fusing.
Caution for all DC models:	Units are not equipped with power switches and activate immediately when connected to a power source.

11. IF cable connection caution:

IF Cable Connection: Caution to Service Personnel

Connecting or disconnecting the IF cable connector when the base station is powered-on may damage the base station equipment.

The base station provides DC power to the outdoor modem through the IF cable. Installers must ensure that the base station indoor equipment is completely powered off before connecting or disconnecting the IF cable at the modem or indoor equipment. Technical service personnel must employ the same cautions when bench-testing equipment prior to field deployment.

12. Do not place the indoor product on or near a direct heat source, and avoid placing objects on the indoor equipment.
13. Do not operate the indoor device near water or in a wet location.
14. Use only a damp cloth for cleaning the indoor device. Do not use liquid or aerosol cleaners. Disconnect the power before cleaning.
15. Locate the indoor equipment on a stable horizontal surface or securely mounted in a 19-inch rack.
16. Protect the system by disconnecting the power if it is not used for long periods.
17. Keep all product information for future reference.

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1.4 Deployment in the USA -- FCC Notices

Important Notice: Deployment in the USA (3650-3700 MHz Band)

The installer/end-user must install and activate the FCC-specific software version for the AN-100U/UX base station before deploying wireless system.

1.4.1 General FCC Notices

1. The Model AN-100U / AN-100UX and its antenna must be professionally installed.
2. ⚠ WARNING -- FCC RF Exposure Warnings

   To satisfy FCC RF exposure requirements for RF transmitting devices, a minimum distance of 20 cm should be maintained between the antenna of this device and persons during device operation. To ensure compliance, operation at closer than this distance is not recommended. The antenna used for this transmitter must not be collocated in conjunction with any other antenna or transmitter.
3. Operation is available for the 50 MHz band 3650-3700 MHz (unrestricted contention based protocol for WiMAX devices).
4. FCC Information to Users @ FCC 15.21 & 15.105:

   This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

   Warning: Changes or modifications not expressly approved by Redline Communications could void the user's authority to operate the equipment.

1.4.2 Installation and Operation

FCC Part 90.1321 guidelines for deployment of RedMAX systems in the frequency band of 3650-3700 MHz, for unrestricted CBP (Contention Based Protocol) in USA includes restrictions on the maximum EIRP for sector controllers and subscriber units. To comply with these guidelines, the following EIRP limitations are applied for deployment in this band:

i) Max EIRP of 25 Watts/25 MHz (equivalent to 1 Watt/1 MHz)

ii) Peak EIRP Power Density of 1 Watt in any 1 MHz slice of spectrum.

To ensure compliance with these restrictions, refer to the following important notices:

1. The 3650-3700 MHz frequency range is a licensed band in the USA and operators must have a valid spectrum license to operate RedMAX equipment using this band.
2. The AN-100U/UX base station requires a Redline FCC-specific software load that is mandatory for operation of the base station within the USA. This software enforces the FCC approved operating range of 3650-3700 MHz.
3. The AN-100U/UX indoor unit, outdoor transceiver, and antenna must be professionally installed.
4. Changes or modifications not expressly approved by Redline Communications could void the user's authority to operate the equipment.
5. The AN-100U/UX transmit power settings must not exceed values stated in the AN-100U/UX User Manual.

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6. Do not connect an AN-100U/UX to an outdoor transceiver until you have confirmed the FCC-specific software is loaded and operational on the AN-100U/UX and the available operating range is 3650-3700 MHz.

1.4.3 FCC Power Settings

FCC regulation part 90.1321 (governing operation in the 3650-3700 MHz band in the US) states that base station transmissions are limited to a maximum transmit power of 1 Watt/MHz (peak EIRP).

AN-100U Power Settings

The following table should be used to configure the maximum transmit power setting on the AN-100U depending on the antenna used:

Table 2: Notices - AN-100U Antenna/Tx Power Setting Combinations for FCC

Redline PN	Ant. Gain (dBi)	Antenna Description	App.	Max. Tx Power GUI Setting	
				3.5 MHz	7 MHz
PA1760EAS	17	Sector Antenna: 60 degree, 17 dBi, vertical polarization.	PMP	16	19
PA1660EASH	15	Sector Antenna: 60 degree, 16 dBi, horizontal polarization.	PMP	18	21
PA1590EAS	15.4	Sector Antenna: 90 degree, 15.4 dBi, vertical polarization.	PMP	18	21
PA1590EASH	15	Sector Antenna: 90 degree, 15 dBi, horizontal polarization.	PMP	18	21
PA14120EAS	14	Sector Antenna: 120 degree, 14 dBi, vertical polarization.	PMP	19	22
PA14120EASH	14	Sector Antenna: 120 degree, 14 dBi, horizontal polarization.	PMP	19	22
A11360EAO	11	Sector Antenna: 360 degree, 11.0 dBi antenna.	PMP	22	23

Note: The RF output power and selection must be professionally programmed and installed by the manufacturer or a trained professional installer. Values do not include implementation (cable) loss of up to 1 dB).

AN-100UX Power Settings

The AN-100UX is certified for use in a splitter configuration. This configuration – using an RF splitter/combiner and RF cables – introduces 10 dB of losses in the transmission path. The following table should be used to calculate the maximum transmit power setting on the AN-100UX:

Table 3: Notices - AN-100UX Maximum Transmit Power Settings for FCC

Channel Size	GUI setting
3.5 MHz	44 dBm – antenna gain (dBi)
7 MHz	47 dBm – antenna gain (dBi)

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Federal Communications Rules for Operation in USA

The following is applicable to operations in the 3650-3700 MHz band:

Use of the correct setting for the following parameter is critical to ensuring the base station operates in compliance with the rules of 47CFR90 subpart Z (Wireless Broadband Services in the 3650–3700 MHz Band):

Noise Threshold

Any attempt by the operator to modify this parameter setting to a value exceeding that allowed by the Redline base station software, or that would otherwise exceed the conditions specified in the operator license, could be a violation of that license.

In addition, operators are advised that, if deemed necessary, the Federal Communications Commission (FCC) may require a specific setting for this parameter in order to ensure equitable sharing of the spectrum.

1.5 Frequency Selection

1.5.1 General

Operation in the FWA band is subject to license. The radio power and channel frequency selections must be set correctly before the installed system is allowed to transmit. The installed system must comply with all governing local, regional, and national regulations. Contact authorities in the country of installation for complete information regarding the licensing regime and operating restrictions for that regulatory domain.

1.5.2 R&TTE Directive 1999/5/EC Statements

Installation

The modem and antenna equipment must be installed by a qualified professional installer and must be installed in compliance with regional, national, and local regulations. It is the responsibility of the system installer and/or system operator to ensure the installed system does not exceed any operational constraints identified by local regulations. Refer to the product User Guide and Installation Guidelines document for detailed information covering the correct steps to ensure power and frequency settings are set correctly before connecting the antenna. Operation in the 3.4-3.6 GHz band is subject to license. Authorities within the country of installation can provide information regarding the licensing regime and restrictions.

Community Language Declarations

The following table contains community language versions of informal statement in accordance with Article 6.3 of Directive 1999/5/EC.

Table 4: Notices - R&TTE: Countries of Use (3.4 GHz & 3.6 GHz)

Country	3400-3600 MHz	Country	3400-3600 MHz	Country	3400-3600 MHz
Austria	✓	Hungary	✓	Poland	✓
Belgium	✓	Iceland	✓	Portugal	✓
Bulgaria	✓	Ireland	✓	Romania	✓
Cyprus		Italy		Slovakia	✓
Czech Republic	✓	Latvia	✓	Slovenia	✓
Denmark	✓	Liechtenstein	✓	Spain	✓

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Table 4: Notices - R&TTE: Countries of Use (3.4 GHz & 3.6 GHz)					
Country	3400-3600 MHz	Country	3400-3600 MHz	Country	3400-3600 MHz
Estonia	✓	Lithuania	✓	Sweden	✓
Finland	✓	Luxembourg	✓	Switzerland	✓
France	✓	Malta	✓	United Kingdom	✓
Germany	✓	Netherlands	✓		
Greece	✓	Norway	✓		

Table 5: Notices - R&TTE Community Language CE Declarations	
Danish	Undertegnede Redline Communications erklærer herved, at følgende udstyr RedMAX Base Station (model AN-100U/AN-100UX) overholder de væsentlige krav og øvrige relevante krav i direktiv 1999/5/EF.
Dutch	Hierbij verklaart Redline Communications dat het toestel RedMAX Base Station (model AN-100U/AN-100UX) in overeenstemming is met de essentiële eisen en de andere relevante bepalingen van richtlijn 1999/5/EG.
	Bij deze verklaart Redline Communications dat deze RedMAX Base Station (model AN-100U/AN-100UX) voldoet aan de essentiële eisen en aan de overige relevante bepalingen van Richtlijn 1999/5/EC.
English	Hereby, Redline Communications, declares that this RedMAX Base Station (model AN-100U/AN-100UX) is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.
Finnish	Redline Communications vakuuttaa täten että RedMAX Base Station (model AN-100U/AN-100UX) tyyppinen laite on direktiivin 1999/5/EY oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen.
French	Par la présente Redline Communications déclare que l'appareil RedMAX Base Station (model AN-100U/AN-100UX) est conforme aux exigences essentielles et aux autres dispositions pertinentes de la directive 1999/5/CE.
	Par la présente, Redline Communications déclare que ce RedMAX Base Station (model AN-100U/AN-100UX) est conforme aux exigences essentielles et aux autres dispositions de la directive 1999/5/CE qui lui sont applicables.
German	Hiermit erklärt Redline Communications, dass sich *dieser/diese/dieses* RedMAX Base Station (model AN-100U/AN-100UX) in Übereinstimmung mit den grundlegenden Anforderungen und den anderen relevanten Vorschriften der Richtlinie 1999/5/EG befindet". (BMWi)
	Hiermit erklärt Redline Communications die Übereinstimmung des Gerätes RedMAX Base Station (model AN-100U/AN-100UX) mit den grundlegenden Anforderungen und den anderen relevanten Festlegungen der Richtlinie 1999/5/EG. (Wien)
Greek	*ΜΕ ΣΗΝ ΠΑΡΟΤΣΑ Redline Communications ΔΗΛΩΝΕΙ ΟΣΙ RedMAX Base Station (model* AN-100U/AN-100UX*) ΣΤΜΜΟΡΦΩΝΕΣΑΙ ΠΡΟΣ ΣΙΣ ΟΤΣΙΩΔΕΙΣ ΑΠΑΙΣΗΣΕΙΣ ΚΑΙ ΤΙΣ ΛΟΙΠΕΣ ΣΥΕΣΙΚΕΣ ΔΙΑΣΑΞΕΙΣ ΣΗΣ ΟΔΗΓΙΑΣ 1999/5/ΕΚ.*
Italian	Con la presente Redline Communications dichiara che questo RedMAX Base Station (model AN-100U/AN-100UX) è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 1999/5/CE.

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Table 5: Notices - R&TTE Community Language CE Declarations	
Portuguese	Redline Communications declara que este RedMAX Base Station (model AN-100U/AN-100UX) está conforme com os requisitos essenciais e outras provisões da Directiva 1999/5/CE.
Spanish	Por medio de la presente Redline Communications declara que el RedMAX Base Station (model AN-100U/AN-100UX) cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 1999/5/CE.
Swedish	Härmed intygar Redline Communications att denna RedMAX Base Station (model AN-100U/AN-100UX) står I överensstämmelse med de väsentliga egenskapskrav och övriga relevanta bestämmelser som framgår av direktiv 1999/5/EG.

1.6 Information For Use In Canada

Usage of this base station is subject to license within Canada. More information regarding licensing requirements is available from Industry Canada (www.ic.gc.ca).

This equipment complies to RSS-192 in the frequency band 3600-3650 MHz and RSS-197 guidelines for deployment of RedMAX systems in the frequency band of 3650-3700 MHz, for unrestricted CBP (Contention Based Protocol).

Table 6: Notices - Canada: Approved Antennas	
A11360EAO	Omni Antenna: 360 degree, 11 dBi.
PA14120EAS	Sector Antenna: 120 degree, 14 dBi sector antenna flat panel, vertical polarization.
PA14120EASH	Sector Antenna: 120 degree, 14 dBi sector antenna flat panel, horizontal polarization.
PA1590EASH	Sector Antenna: 90 degree, 15 dBi High performance sector antenna, horizontal polarization offers improved cross polarization and F/B performance.
PA1660EAS	Sector Antenna: 60 degree, 16 dBi High performance sector antenna, vertical polarization, offers improved cross polarization and F/B performance.
PA1760EAS **PA1660EASH**	Sector Antenna: 60 degree, 16 dBi High performance sector antenna, horizontal polarization, offers improved cross polarization and F/B performance.
PA1690EAS	Sector Antenna: 90 degree, 16 dBi High performance sector antenna, vertical polarization, offers improved cross polarization and F/B performance.
PA1760EAS	Sector Antenna: 60 degree, 17 dBi, vertical polarization.

1.7 Important Service Information

1. Refer all repairs to qualified service personnel. Removing the covers or modifying any part of this device, as this voids the warranty.
2. Locate and record the serial number of the base station indoor equipment, antenna, and modem for future reference. Record the MAC address of the indoor equipment.
3. Redline does not endorse or support the use of outdoor cable assemblies: i) not supplied by Redline, ii) third-party products that do not meet Redline's cable and connector assembly specifications, or iii) cables not installed and weatherproofed as specified in this manual. Refer to the Redline Limited Standard Warranty and RedCare service agreements.

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4. Disconnect the power to this product and return it for service if the following conditions apply:

- The base station equipment does not function after following the operating instructions outlined in this manual.
- Liquid has been spilled, a foreign object is inside, or the indoor equipment has been exposed to rain.

  The equipment has been dropped or the housing is damaged.

1.8 WEEE Product Return Process

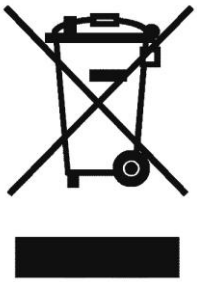

Figure 1: Notices - WEEE Logo

In accordance with the WEEE (Waste from Electrical and Electronic Equipment) directive, 2002/96/EC, Redline Communications equipment is marked with the logo shown above. The WEEE directive seeks to increase recycling and re-use of electrical and electronic equipment. This symbol indicates that this product should not be disposed of as part of the local municipal waste program. Contact your local sales representative for additional information.

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2

2 RedMAX Base Station Overview

Congratulations on your purchase of the Redline Communications model Access Node-100U/UX wireless broadband base station single sector base station. Redline Communications is a world leader in design and production of Broadband Fixed Wireless (BFW) systems.

2.1 Introduction

The base station is a carrier class IEEE 802.16-2004 compliant wireless device for deployment of point-to-multipoint (PMP) and point-to-point (PTP) systems.

Figure 2: Intro - AN-100U Base Station, TB Radio, and Antenna

Figure 3: Intro - AN-100UX Base Station, High Power HTB Radio, and Antenna

The base station consists of an indoor unit (IDU) and outdoor modem and antenna (ODU). Each operational RedMAX wireless broadband network segment is comprised of a RedMAX base station and one or more WiMAX Forum Certified subscribers. Each subscriber registers and establishes a bi-directional data link with the base station.

The RedMAX base station is (part of) the 802.16 definition of a base station. A RedMAX base station functions as a central hub or concentrator, connected to a WAN network access point, and managing wireless links for remote subscribers. The RedMAX base station enforces the Quality of Service (QoS) settings by controlling all uplink and

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downlink traffic scheduling -- providing non-contention based traffic with predictable transmission characteristics.

2.2 IEEE 802.16 / WiMAX Compliance

The IEEE 802.16-2004 specifications describe a PMP broadband wireless access standard for systems operating in the frequency range of 2-11 GHz, and 10-66 GHz. This standard includes descriptions for both the Media Access Control (MAC) and the physical (PHY) layers.

The RedMAX base station is compliant to the following IEEE 802.16-2004 WirelessMAN-OFDM and WirelessHUMAN-OFDM Physical Layer Profiles:

- ProfP3_3.5: WirelessMAN-OFDM PHY profile for 3.5 MHz channelization (Rel. 1.0)
- ProfP3_7: WirelessMAN-OFDM PHY profile for 7 MHz channelization (Rel. 1.1)

Note that the 802.16 standards are subject to amendment, and RedMAX product design compliance applies to a specific revision of the standard. The RedMAX product does not support mesh communication, but does support subscriber-to-subscriber communication using TLS.

Redline is an active member of the IEEE 802.16 standards committee and has been instrumental in creating the original 802.16 standards. Redline is also active in recommending, writing and following-up on new amendments to the 802.16 specifications.

Redline is an active member of the WiMAX Forum™ and is participating in interoperability testing in the WiMAX Forum.

2.3 PHY Specification

The base station is designed for 2-11 GHz operation based on the WirelessMAN-OFDM PHY definition in the IEEE 802.16 specification. Refer to the system specifications for supported frequency ranges.

2.4 OFDM (256 FFT)

The base station uses Orthogonal Frequency Division Multiplexing (OFDM). OFDM is a multi-carrier transmission technique where the data stream is split and transmitted (at a reduced rate) in parallel streams on separate sub-carriers. OFDM uses the Fast Fourier Transform (FFT) algorithm to implement modulation and demodulation functions. Using adequate channel coding and bit-interleaving, OFDM can perform very well in severe multipath environments, mitigate frequency selective fading and provide high spectral efficiency.

2.5 Features

2.5.1 Privacy

The base station is hardware ready to provide encryption for user traffic. The MAC header of 802.16 contains the information Encryption Control (EC), Encryption Key sequence (EKS) , and Connection Identifier (CID) necessary to decrypt a payload by the receiver. Protection of the payload is indicated by the EC bit field. A value of '1' indicates the payload is cryptographically protected and the EKS field contains meaningful data. A value of '0' indicates the payload is not cryptographically protected. The EKS field contains a sequence number used to identify the current generation of keying material.

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2.5.2 Time Division Duplexing (TDD)

The base station system uses time division duplexing (TDD) to transmit and receive on the same RF channel, or using separate RF channels using half-duplex FDD (HD-FDD) mode (AN-100U only). These are both non-contention based methods for providing an efficient and predictable two-way PTP or PMP cell deployment. All uplink and downlink transmission scheduling is managed by the base station. The base station sends data traffic to subscribers, polls for grant requests, and sends grant acknowledgements based on the total of all traffic to all subscribers.

2.5.3 Coding Rate

Each burst of data transmitted over the wireless interface is padded with redundant information, making it more resistant to potential over-the-air errors. The coding rate is the ratio of user data to the total data transmitted including the redundant error correction data. The base station supports coding rates of 1/2, 2/3, and 3/4.

2.5.4 Modulation

The modulation technique specifies how the data is coded within the OFDM carriers. The base station supports BPSK, QPSK, 16 Quadarature Amplitude Modulation (QAM), and 64 QAM modulation.

2.5.5 Reed Solomon Error Correction

Outer Reed-Solomon and inward Convolution Coding (RS-CC) error correction is enabled for all traffic rates, with the exception of BPSK 1/2 where only inward Convolution Coding is used. These low-level processes can correct bursts of errors in received messages and reduce the number of retransmissions.

2.5.6 Time Synchronization

When operating two or more collocated base stations, transmitter operations MUST be synchronization to minimize inter-sector interference. Each base station has a synchronization port located on the front panel to receive synchronization pulses.

2.6 Deployment Models

The base station supports point to point (PTP) and point to multipoint (PMP) scenarios.

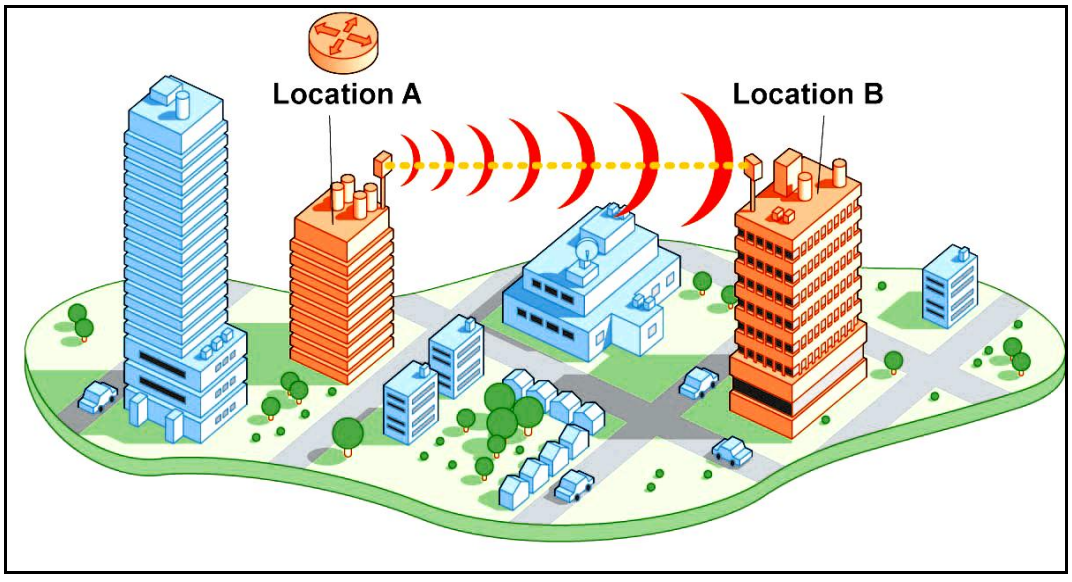

Figure 4: System - PTP Line of Sight Deployment

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2.6.1 PTP Deployment

When deployed in a PTP configuration the base station establishes a dedicated bi-directional link to a single subscriber. The PTP deployments typically use a directional narrow beam antenna for both ends of the link.

2.6.2 PMP Deployment

When deployed in a PMP configuration the base station establishes bi-directional links to more than one subscriber. PMP deployments typically use a wide beam (sector) antenna at the base station and a narrow beam antenna at the subscriber. Service flows are used to police service level agreements for each subscriber.

2.6.3 Channelization

The base station is a frequency-specific system, with the frequency band defined by the modem. The use of the operating band must be in accordance with European Conference of Postal and Telecommunications Administrations (CEPT) Recommendation 14-03.

The base station divides the available frequency band into channels. Allocation of channels during deployment is dependent on spectrum availability in the licensed FWA band and local licensing requirements and conditions. Channel selection allows planners to obtain the maximum geographic coverage, while avoiding frequency contention in adjacent sectors.

2.6.4 Non Line-of-Sight

The RedMAX system supports line-of-sight (LOS), optical line-of-sight (OLOS), and non line-of-sight (NLOS) operation. A clear LOS link has no obstacles within 60% of the first Fresnel zone of the direct path. An OLOS link has obstructions within 60% of the first Fresnel zone, but a visible path exists between the base station and subscriber. Refer to the following illustration.

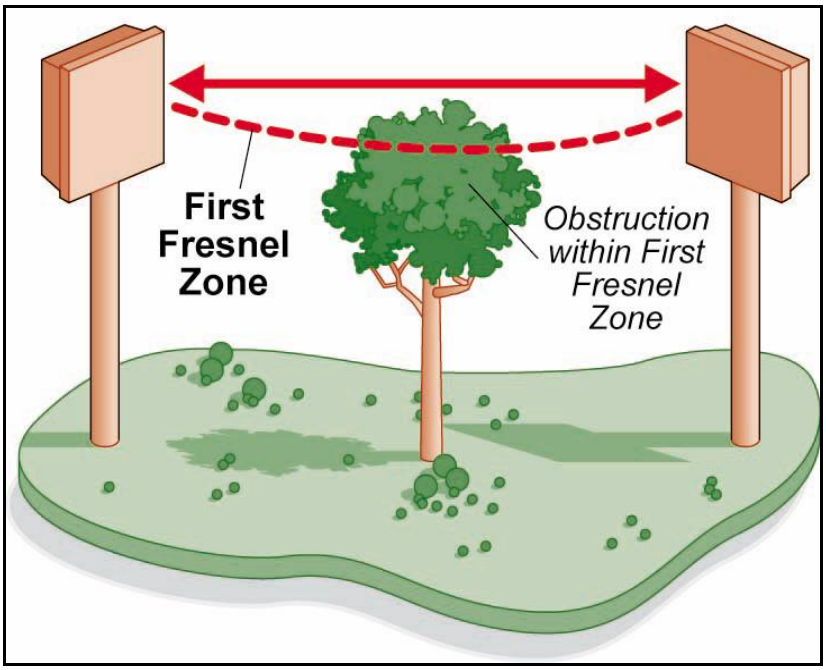

Figure 5: System - Fresnel Zone

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A wireless link is considered non LOS if natural or man-made structures block the visible path between the base station and the subscriber. In this case, a wireless link can be established only if a reflective path can be established between the base station and subscriber.

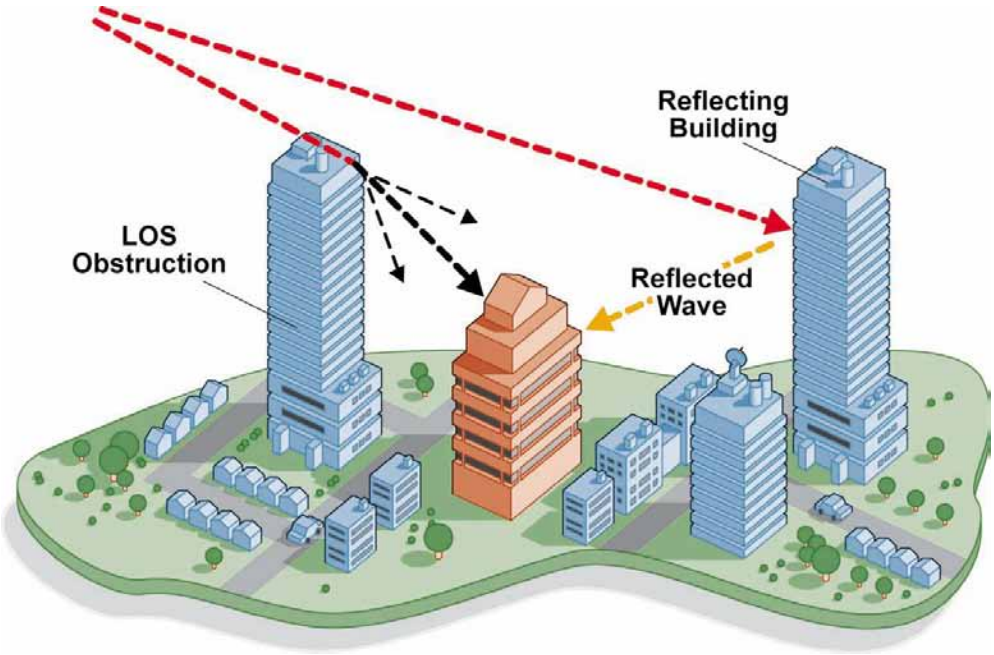

Figure 6: System - Non-Line of Sight Deployment

2.7 Service Flows

Service flows are a key feature of the 802.16 standard. A service flow represents a unidirectional data flow between the base station and subscriber. Downlink service flows control traffic flow from the base station to the subscriber. Uplink service flows control traffic flow from the subscriber to the base station. Bidirectional data flow requires that two service flows be defined: one for the uplink, and another for the downlink. Each service flow is assigned unique QoS settings.

The base station allows multiple service flows to be configured for each subscriber in a sector. This allows service providers to offer different service levels and segregate traffic flows having different QoS requirements.

A service flow is partially characterized by the following attributes:

1. A 32-bit Service Flow ID (SFID) is assigned to all existing service flows. The SFID serves as the principal identifier for the Service Flow and has an associated direction.
2. A 16-bit Connection ID (CID) is associated with each active SFID (connection active).
3. A set of QoS parameters specifying the required resources. The principal resource is bandwidth, but the specification may also include latency requirements.
4. A set of QoS parameters defining the level of service being provided.

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2.7.1 Service Flow Classification

Data packets are forwarded by the subscriber based on classification rules. Classification rules require examining each packet for pattern matches such as destination address, source address, or VLAN tag. All classification is defined at the base station and the classification parameters are downloaded to the subscriber.

RedMAX supports service flows with different classification types including: 802.3 Ethernet, 802.1Q VLAN, IPV4, IPV4 Over 802.3 and IPV4 Over 802.1Q -- with options to classify based on Source and Dest of MAC and IP addresses, VLAN tag and Vlan priority, Src and Dst port number, TOS Value and Ethernet protocol type.

2.7.2 Dynamic Service Addition

Service flows are defined and stored in the base station. For each service flow to be established, the base station sends a setup message to the subscriber specifying the required set of QoS parameters. The subscriber responds to each request by accepting or rejecting the setup message.

A service flow may be pre-provisioned or can be dynamically created and deleted without service outage. This is useful for supporting multiple subscribers in a single sector. New subscribers can be added and existing subscribers can be removed or have service levels modified.

Setup messages are sent by the base station following any subscriber power-cycle, loss and recovery of the wireless link to a subscriber, or any service flow add/delete operation at the base station.

2.7.3 Default Service Flows

Default UL/DL service flows are created automatically for each registered subscriber. These service flows are used to pass all traffic not matching any user-defined service flow (such as broadcast ARP) between the base station and subscribers. The default service flow bandwidth is limited for each subscriber. Refer to Default UL/DL Service Flows on 56, Default Service Flows on page 114, and interfaces on page 90.

2.7.4 Scheduling

The base station enforces QoS settings for each service flow by controlling all uplink and downlink traffic scheduling. This provides non-contention based traffic model with predictable transmission characteristics. By analyzing the total of requests of all subscribers, the base station ensures that uplink and downlink traffic conforms with the current service level agreements (SLAs). Centralized scheduling increases predictability of traffic, eliminates contention, and provides the maximum opportunity for reducing overhead.

A regular period is scheduled for subscribers to register with the base station. These subscribers may be newly commissioned or have been deregistered due to service outage or interference on the wireless interface. This is the only opportunity for multiple subscribers to transmit simultaneously.

Real-Time Polling Service (rt-PS)

The base station schedules a continuous regular series of transmit opportunities for the subscriber to send variable size data packets. The grant size is based on the current data transfer requirement. Typical applications include streaming MPEG video or VOIP with silence suppression. This is efficient for applications that have a real-time component and continuously changing bandwidth requirements.

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Non-Real-Time Polling Service (nrt-PS)

The base station schedules regular transmit opportunities for the subscriber to send variable size data packets. Typical applications may include high bandwidth FTP. The polling period may typically be one second or less, even during periods of network congestion.

Best Effort (BE)

The base station schedules transmit opportunities for the subscriber to send traffic based on unused bandwidth after all higher level traffic scheduling requirements are serviced. Typical applications may include Internet access and email. Best effort service flows can be assigned a priority of 0 to 7.

Unsolicited Grant Service (UGS)

The base station schedules a continuous series of transmit opportunities for the subscriber to send fixed size data packets. This schedule supports real-time applications including VoIP or TDM transport. The UGS pre-scheduled grants guarantee reserved bandwidth and reduce latency introduced by repetitive grant requests. The service flow will not transmit packets larger than nominal grant interval.

Traffic Scheduling Algorithm

The base station scheduling algorithm uses two scheduling passes. On the first pass, the scheduler attempts to allocate bandwidth to meet the minimum rates for all active service flows. If there is available bandwidth remaining at the end of the first pass, the scheduler executes a second pass and attempts meet all specified maximum rates. During both passes, bandwidth allocations are assigned based on the following order of assessment:

1. Priority of the scheduling service type, from highest to lowest (rtPS first, then BE).
2. Traffic Priority setting when multiple service flows have the same service type.

Wireless transmission bandwidth is optimized by granting allocations based only on traffic available for immediate transmission: only the required bandwidth is allocated, and idle service flow channels do not receive any bandwidth allocation.

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3

3 Physical Description

3.1 Base Station Indoor Unit (IDU)

This section describes the characteristics of the base station. All indicator LEDs, power receptacles, data ports, and the reset switch are located on the front panel. A ground terminal is located at the rear of the base station.

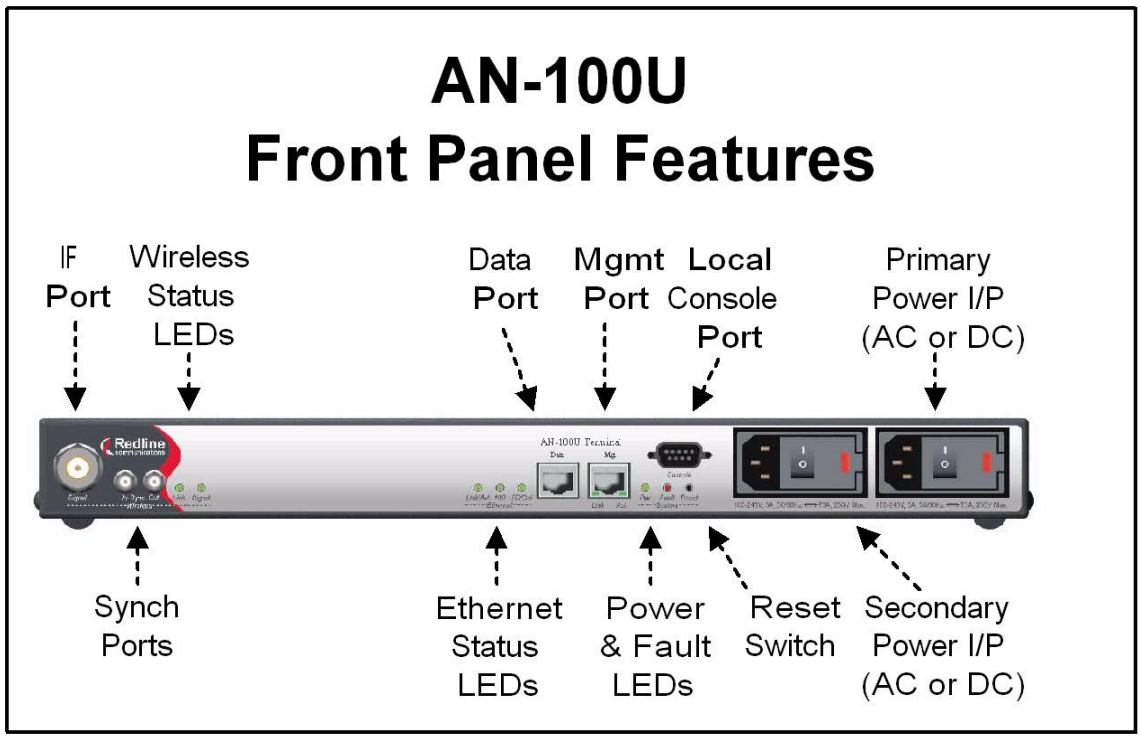

Figure 7: System - AN-100U Front Panel

Important Information

AC & DC Power Options

The AC and DC power input options are different for the AN-100U and the AN-100UX. Review the documentation carefully before connecting power.

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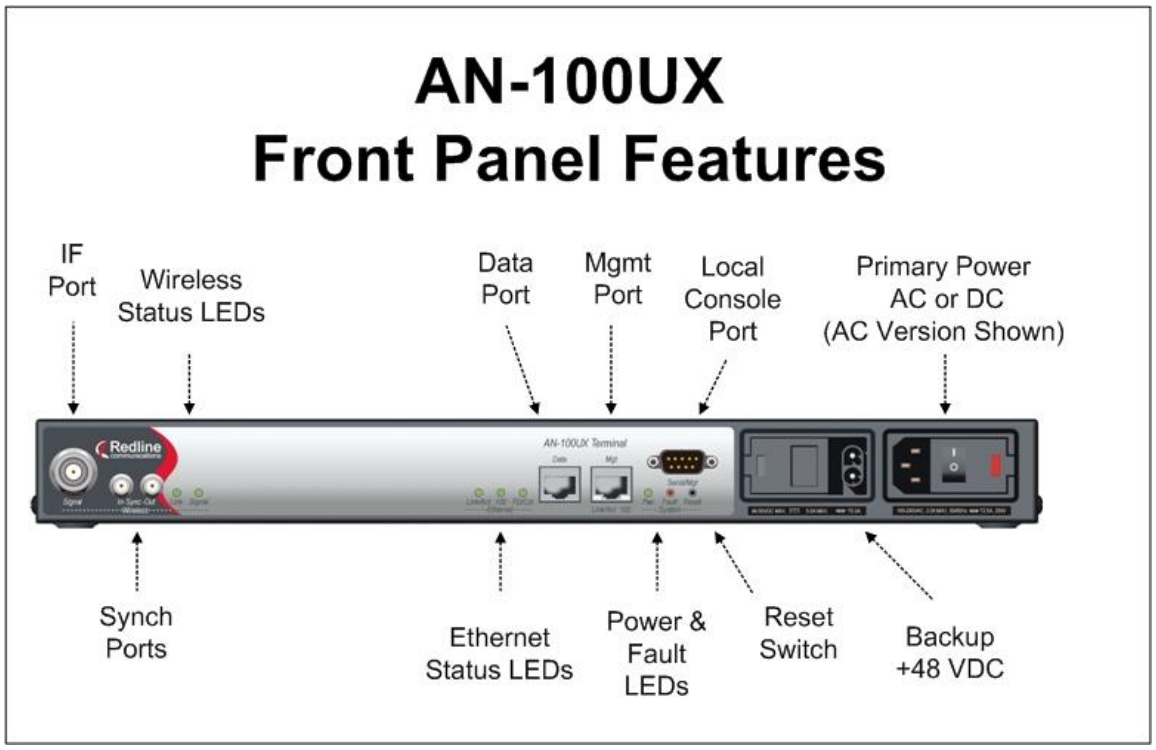

Figure 8: System - AN-100UX Front Panel

3.1.1 Mounting

The indoor equipment can be freestanding on a flat surface or in a 19-inch rack.

3.1.2 Power Supply

The AN-100U and AN-100UX (high power) equipment have different power supply features. Read the following section carefully to determine the correct power requirements and options. All models feature double pole/neutral fusing. Refer to the Installation Guidelines manual for additional information about DC power wiring.

Warning to service personnel:

Caution for all AC and DC models – Double Pole/Neutral fusing.

AN-100U

Power supply options include single or dual AC or DC supplies, or a combination of AC and DC power supplies. Cables are included with both AC and DC power supplies.

Table 7 - IDU Installation - RedMAX AN-100U Power Specifications

	Voltage range [V]	Tolerance [%]	Power consumption max. [W]	Max. Current [A]	Inrush current [1] [A]
AC Input [2]	100-240 VAC	10%	75	2	35
DC Input [2]	24-60 VDC	20%	75	6	40

1. Typical Inrush current is less then 500 us. DC: measured, AC: P/S manufacturers data.
2. Auto-sensing.

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AN-100UX

AN-100UX Power supply options include single AC or DC types. Cables are included with AC and DC power supplies. Backup power can be supplied only from a +48 VDC power supply.

Table 8 - IDU Installation - RedMAX AN-100UX Power Specifications

	Voltage range [V]	Tolerance [%]	Power consumption max. [W]	Max. Current [A]	Inrush current [1] [A]
Main AC Input [2]	100 - 240 VAC	10%	120	2	100
Main DC Input	48 - 60 VDC	20%	120	5	70
Backup. DC Input	+48 VDC	5%	120	5	30

1. Typical Inrush current is less then 500 us. DC: measured, AC: P/S manufacturers data.
2. Auto-sensing.

IMPORTANT: DC Polarity

The AN-100UX backup power supply is DC type and must be connected using positive polarity: the +48 VDC must be connected to +Ve input on the AN-100UX. Refer to Installation Guidelines for additional details.

3.1.3 Wireless Section

This section describes the wireless port, time synchronization ports, and wireless LEDs.

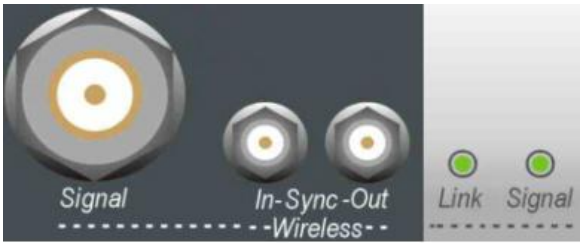

Figure 9: System - AN-100U/UX Front Panel Wireless Section

IF Port (Radio Control)

A female N-type port provides connection via a coaxial cable. This port provides the following functions:

- Local oscillator signal for synchronization between the terminal and radio
- Telemetry signals for control and monitoring the modem
- IF modulated data to/from the radio (wireless interface)
- DC power to the transceiver (see following table)

Table 9: System - AN-100U/UXIF Cable Voltage

AN-100U	24 VDC
AN-100UX	48 VDC

Time Synchronization Port

The synchronization interface has two SMA female connectors located on the front panel. Refer to section for additional information. When operating two or more collocated base stations (BSs), transmitter operations MUST use synchronization to minimize inter-sector interference. Refer to the RedMAX Base Station Installation Guidelines for complete details.

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Wireless LEDs

Link LED

The wireless Link LED flashes once every 8 frames to provide a 'heartbeat' indicator. This indicates proper communication with the outdoor unit (ODU), and that the framer is operating correctly. If this LED is not flashing, there is no possibility of establishing a wireless link.

Table 10: System - Wireless Link LED Indications	
LED State	**Description**
OFF	Wireless interface unavailable.
FLASH	Wireless interface enabled and functioning correctly.

Signal LED

The Signal LED flashes each time a message is received from any subscriber. Message types include: periodic ranging messages, bandwidth requests, and user data traffic.

Table 11: System - Wireless Signal LED Indications	
LED State	**Description**
OFF	No wireless link activity.
ON	Messages being received from subscribers.

3.1.4 Ethernet Section

This section describes the Ethernet LEDs and port connections.

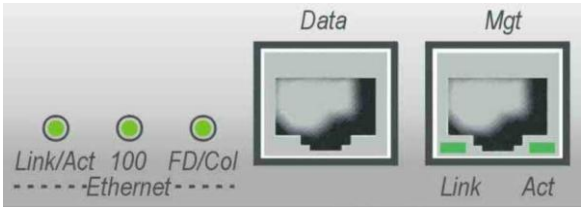

Figure 10: System - AN-100U/UX Front Panel Ethernet LEDs and Ports

Data Port

The Data port is always enabled. The port can be programmed to operate in full duplex or half duplex mode and at 10 Mbps or 100 Mbps.

Data Port LEDs

Data Port Link/Act LED

The Link/Act LED lights green when the LAN is functioning properly.

Table 12: System - Ethernet Data Port Link/Act LEDs	
LED	**Description**
ON	Link is present.
FLASH	Link is present and there is data activity.
OFF	Link is not active.

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Data Port 100 LED

The 100 LED lights solid green when the terminal is operating at 100 Mbps. The LED is off when operating at 10 Mbps.

Table 13: System - Ethernet Data Port 100 LEDs	
LED	**Description**
ON	LAN is operating at 100 Mbps.
OFF	LAN is operating at 10 Mbps.

Data Port FD/Col LED

The FD/Col LED lights green when the port is operating in Full Duplex mode. The LED flashes when collisions are detected. There are always collisions occurring on a Half-Duplex link.

Table 14: System - Ethernet Data Port FD/Col LEDs	
LED	**Description**
ON	Full duplex operation
FLASH	Packet collisions detected on the LAN
OFF	Half Duplex operation

Mgt Port

The Mgt port is used for out-of-band management and diagnostics. This port can be enabled and disabled. The port can be programmed to operate in full duplex or half duplex mode and at 10 Mbps or 100 Mbps.

Mgt Port LEDs

Mgt Port Link (Link/Act) LED

The Mgt port Link LED lights green when a link is established.

Table 15: System - Ethernet Mgt Port Link LEDs	
LED	**Description**
ON	Ethernet interface is present.
FLASH	Ethernet interface is present and there is data activity.
OFF	Ethernet interface is not active.

Mgt Port Act (100) LED

The 100 LED lights solid green when the Mgt port is operating at 100 Mbps. The LED is off when operating at 10 Mbps.

Table 16: System - Ethernet Mgt Port Act LEDs	
LED	**Description**
ON	Ethernet interface is operating at 100 Mbps.
OFF	Ethernet interface is operating at 10 Mbps.

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3.1.5 System Section

This section describes other general features of the front panel.

System LEDs

The System LEDs indicate power supply status and system faults.

Figure 11: System - AN-100U/UX System LEDs and Reset Switch

System Pwr LED

The Pwr LED lights green to indicate normal operation.

Table 17: System - Pwr LED Indications	
LED	**Description**
ON	Normal operation.
FLASH	Indicates an issue with the system power supplies: AN-100U: When dual power supplies are installed, and the secondary power supply is not available (failed or powered off). AN-100UX: The primary or backup power supplies is not available (failed or powered off).
OFF	System is turned off.

System Fault LED

The Fault LED lights red when a system fault is detected.

Table 18: System - Fault LED Indications	
LED	**Description**
OFF	Normal operation.
FLASH	Indicates an issue with one or more of the system power supplies: AN-100U: When dual power supplies are installed, and the secondary power supply is not available (failed or powered off). AN-100UX: The primary or backup power supply is not available (failed or powered off).
ON	Serious problem with the system hardware. Refer to the Troubleshooting section.

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Reset Switch

The **Reset** switch is recessed in the front panel of the terminal. To operate the switch, use a small narrow object (i.e., bent paper clip) to depress the switch.

Table 19: System - Front Panel Reset Switch	
Operation	**Result**
Depress switch less than 3 seconds	Short-reset. A short-reset is equivalent to cycling the terminal power off/on. Statistics counters are reset.
Depress switch longer than 3 seconds	Long-reset. A long-reset sets the IP address and password to the factory defaults. Refer to Troubleshooting section.

3.1.6 Grounding Connection

A ground terminal is located on the rear of the terminal. Correct grounding is very important for safe operation of wireless equipment.

3.1.7 Console Port

The console port requires a crossover (null modem) cable to connect directly to a PC serial port emulating a VT-52 or VT-100 terminal. The following table lists the default settings for the Console port:

Table 20: System - AN-100U/UX Console Port Default Settings	
Baud	57,600
Data Bits	8
Flow Control	None
Parity	None
Stop Bits	1

The following table lists the Console port pinout and associated signals.

Table 21: System - AN-100U/UX Console Port (RS-232) Pinout				
Pin	**Name**	**RS232**	**V.24**	**Description**
2	RXD	BB	104	Receive Data
3	TXD	BA	103	Transmit Data
5	GND	AB	102	System Ground

Note: V.24 column is ITU-TSS V.24 circuit name.

3.2 Radio Outdoor Unit (ODU)

3.2.1 Transceiver

The radio modem is housed in a weatherproof aluminum alloy case. The modem features are listed in the following sections.

TB Radio

The TB3x3yF7 series of radios are for use only with the AN-100U. These radios operate on 24 VDC and can be mounted using the standard and heavy-duty antenna mounting brackets.

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Figure 12: System - TB Transceiver with Antenna

HTB Radio

The HTB3x3yF7 high-power series of radio are for use only with the AN-100UX. These radios operate on 48 VDC and have integrated mounting brackets. The AN-100U will not recognize HTB-type radios (e.g., event log will indicate log invalid radio type).

Figure 13: System - HTB High-Power Transceiver with Antenna

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IF Port

The modem has a female N-type port for connection to the terminal using a coaxial cable. Through this port and cable, the modem:

- Sends/receives IF modulated data to/from the terminal.
- Transmits status information to the terminal.
- Receives control information from the terminal.
- Receives DC power from the terminal.

RF Port

The modem RF port (female N-type connector) is used for sending/receiving the RF signal to/from the antenna. A short coaxial cable is provided to connect the modem to the antenna.

3.2.2 Antenna

The antenna RF port (female N-type connector) is for sending/receiving the RF signal to/from the modem. A short coaxial cable is provided to connect the antenna to the modem.

3.2.3 Mounting Brackets

AN-100U

A vertical-mount bracket is provided for mounting the AN-100U TB radio and flat panel type antennas. The mounting bracket can accommodate 4.45 - 11.45 cm (1 ¾ - 4 ½") OD masts found on many commercial tower installations. Separate mounting brackets are provided for parabolic antennas.

AN-100UX

The AN-100UX HTB antenna has an integrated mounting bracket that can accommodate 4.45 - 11.45 cm (1 ¾ - 4 ½") OD masts found on many commercial tower installations. A separate mounting bracket is provided for mounting the antenna.

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4

4 Web Interface

All configuration and monitoring functions can be performed using the web-based interface described in detail in this chapter.

4.1 System Menu

When you login to the base station, the **General Information** page is displayed. A menu of all available monitoring and configuration screens is located at the left side of the screen. Point and click any of the items in the menu to display the selected screen.

Figure 14: Web: Base Station System Menu

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The debug user has unrestricted access to all screens and controls. All other users have restricted access. See the following table for details.

Table 22: System - Base Station Screens and Access Control

Function	Screen Title	Guest Access	Admin Access	Debug Access	Description
Monitoring	General Info	√	√	√	View general system information, Ethernet settings, and wireless settings.
	Status	√	√	√	View statistics for the wireless interface, Ethernet data port, and management port.
	SS Info	√	√	√	View system information, Ethernet settings, and wireless statistics for active subscribers.
	Event Log	√	√	√	View system activity and error messages.
	Auto Refresh		√	√	Select the rate to automatically refresh the web screen.
Service Flow Configuration.	Subscribers		√	√	Summary of registered subscribers.
	Service Classes		√	√	Define the set of service classes.
	Service Flows		√	√	Define service flows based on the service classes.
	Classifiers		√	√	Define classifiers for each service flow.
	Manage		√	√	Activate service flows.
Interfaces	Wireless Interface		√	√	View and modify RF, PHY, and MAC settings for the wireless interface.
	Ethernet Interface		√	√	View and modify the Ethernet network interface settings.
	Management Interface		√	√	View and modify the IP and DHCP network interface settings.
Admin Tools	Advanced Config		√	√	View and modify advanced wireless interface settings.
	Software Upgrade		√	√	Upload new system software and select the software version to load at startup.
	Backup and Restore		√	√	Backup and restore configuration settings using remote FTP server.
	SNMP Access Control List		√	√	Manage access control for SNMP managers.
	SNMP Trap Receiver List		√	√	Send SNMP trap messages to specified SNMP managers.
Accounts Management			√	√	Add users & change password.
Reboot			√	√	Reboot the base station terminal.

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4.1.1 Configuration Using a Web Browser

1. Set the IP address of your PC to the following settings:

   IP Address: 192.168.101.110

   Subnet mask: 255.255.255.0

2. Connect the host (laptop) computer directly to the Data port of the base station terminal using an RJ-45 Ethernet (straight-through) cable.
3. Power-on the base station terminal and restore the factory default settings by depressing the reset switch on the front panel for more than five (5) seconds.
4. Launch a Web Browser on the PC and enter the terminal IP address in the browser address field (192.168.101.3). The General Information screen is displayed and the operator can now login to the terminal.

Figure 15: Web: Access - Browser Address Field

Click on any configuration menu item to activate the login dialog screen.

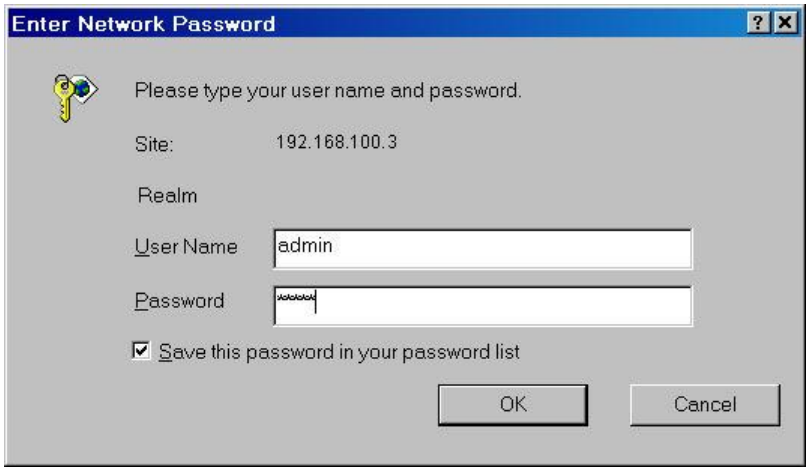

Figure 16: Web: Access - Base Station Login Screen

Enter the default user name and password:

User Name: admin

Password: admin

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4.2 Monitoring Screens

This section describes the screens displaying system information and statistics.

4.2.1 General Info

Click **General Information** in the system menu (left side of screen) to view general information, management settings, and the system front panel LEDs.

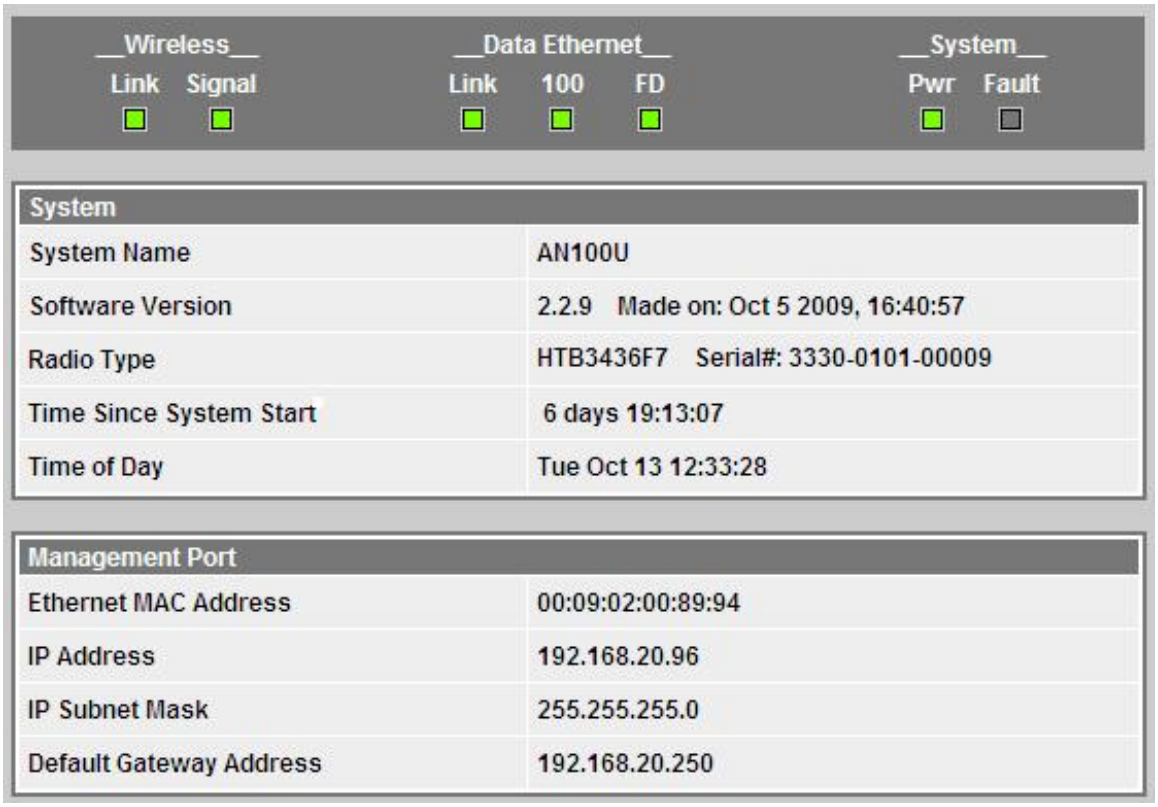

Figure 17: Web: Monitoring - General Information Screen

System

System Name: Assigned name for this base station.

Software Version: Current version of software running on the base station.

Radio Type: Identifies the type of radio connected to this base station. The serial number is displayed for 'HTB' (high power) radios.

Time Since System Start: Time elapsed since the base station was last rebooted.

Time of Day: Current date and time. Requires SNTP network server interface to be enabled. Refer to section 4.4.3: Management Interface on page 69.

Management Port

Ethernet MAC Address: Base Station MAC address.

IP Address: Base Station network IP address.

IP Subnet Mask: Base Station network IP subnet mask.

Default Gateway Address: IP address of the default network gateway.

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4.2.2 Status

Click **Status** in the system menu (left side of screen) to view status information about the wireless interface and Ethernet management interface. Values are updated according to the screen refresh rate.

CINR [dB]	3.0	RF Tx Power [dBm]	20
Traffic Downlink [kbps]	0	Traffic Uplink [kbps]	0
BW Margin Downlink [kbps]	13824	BW Margin Uplink [kbps]	3110
CRC Errors	0	Registered SS's	0
Air Interface Status	enabled	SC Synchro Status	No Synchro
IDU Temperature [Celsius]	45	ODU Temperature [Celsius]	41
Power Supply Status	AB-On	Fans Status	main+secondary
Active DL Service Flows	0	Active UL Service Flows	0
DL SMC Rate [kbps]	0	UL SMC Rate [kbps]	0
DL Bandwidth Usage [%]	0	UL Bandwidth Usage [%]	0
Reference RSS [dBm]	-70	Noise Level [dBm]	-101.1
Narrowest Subchannel	1/2-Subch		

Figure 18: Web: Monitoring - Status - Wireless Status Screen

Wireless Status

CINR [dB]: Mean Carrier/(Interference + Noise) ratio. The CINR value is calculated and displayed for each automatic screen refresh. The CINR measured by the base station is based on the signal from the subscriber. Based on this value, the base station may request that the subscriber change modulation rate.

Traffic Downlink [kbps]: Current rate of traffic transmitted to subscribers.

BW Margin Downlink [kbps]: This is the currently available downlink bandwidth in the sector. If this value becomes zero, the sector controller can not guarantee the QoS for all downlink service flows and a warning message is entered in the base station event log.

The BW Margin Downlink value is updated regularly using the minimum traffic settings for all active uplink service flows, the base station uplink ratio, and the uplink modulation of each subscriber. The BW Margin Downlink value is also available through SNMP, and CLI.

CRC Errors: Number of CRC errors detected on packets received from subscribers. This counter is reset when the base station is rebooted.

Note: The CRC Errors counter in the SS Info screen is reset when a subscriber is registered.

Air Interface Status: Status of the base station modem:

Enabled - Transceiver is operating normally.

Disabled - Transceiver is disconnected, disabled, or defective.

IDU Temperature [Celsius]: Internal temperature of the indoor terminal.

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Power Supply Status: Display the status of the power circuits.

A-On - Terminal is equipped with AC circuits only.

D-On - Terminal is equipped with DC circuits only.

A-D - Terminal is equipped with AC and DC circuits.

Active DL Service Flows: Number of currently active downlink service flows.

DL SMC Rate [kbps]: Data rate for SMC channel.

DL Bandwidth Usage [%]: Current usage of downlink channel.

Reference RSS [dBm]: The Reference RSS setting is the target value for average Received Signal Strength (RSS) for subscribers RF signals received by the base station.

This target value allows automatic adjustment of the subscriber Tx power for optimum performance with the minimum of RF interference. The suggested default setting for the Reference RSS value is:

Table 23: System - Configuration - Reference RSS (dBm)

Channel Size	Initial Setting
3.5 MHz	-75 dBm
7.0 MHz	-72 dBm

These are the suggested initial settings; adjustments to this target value must be made based on the individual RF characteristics of each deployed sector. The RSSI value (dBm) for each subscriber can be monitored using the base station SS Info screen (Web interface). Tx power adjustments are based on a number of factors, and differences of up to 7 dB may be observed between the Reference RSS setting and measured RSSI.

Narrowest Subchannel: The narrowest mandatory sub-channel type available to use with the current configuration (Channel Bandwidth, Frame Duration, Cyclic Prefix and DL Ratio) and basic management activity. Refer to the folllowing table for details.

Table 24: System - Configuration - Subchannelization Status

Status Message	Available Subchannelization Types
fullChannel	Full only
1/2 subchannel	Full, and 1/2
1/4 subchannel	Full, 1/2, and 1/4
1/8 subchannel	Full, 1/2, 1/4, and 1/8
1/16 subchannel	Full, 1/2, 1/4, 1/8. and 1/16

RF Tx Power [dBm]: Radio transmission output power level.

Traffic Uplink [kbps]: Current rate of traffic received from subscribers.

BW Margin Uplink [kbps]: This is the currently available uplink bandwidth in the sector. If this value becomes zero, the sector controller can not guarantee the QoS for all uplink service flows and a warning message is entered in the base station event log.

The BW Margin Uplink value is updated regularly using the minimum traffic settings for all active uplink service flows, the base station uplink ratio, and the uplink modulation of each subscriber. The BW Margin Uplink value is also available through SNMP, and CLI.

Registered SS's: Number of subscribers currently registered with the base station.

SC Synchro Status: Status of the base station time synchronization. Refer to the RedMAX Base Station Installation Guidelines for complete details of the synchronization feature.

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No Synchro - Base station is not using synchronization.

Master with GPS Synchro - Base station is Master and is synchronized to an external GPS clock.

Master - Base station is Master and is using internal clock.

Slave - Base station is Slave.

Backup Master - Base station is Backup Master and will assume Master operations if Master is unavailable.

ODU Temperature [Celsius]: Internal temperature of the modem.

Fans Status: Display the status of the system cooling fans.

oneFanOn - A single cooling fan is operating.

twoFansOn - Both cooling fans are operating.

Active UL Service Flows: Number of currently active uplink service flows.

UL SMC Rate [kbps]: Data rate for uplink channel.

UL Bandwidth Usage [%]: Current usage of uplink channel.

Noise Level [dBm]: Indicates the noise level. This value is measured by sampling the radio receiver input during idle periods (base station and subscribers are not transmitting) and provides an indication of the average level of interference in the sector.

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Interface

The interface panel provides statistics for the wireless interface (802.16), the data Ethernet port Data), and the management (Mgmt) Ethernet port. Select the desired interface and click **Refresh** to update the screen.

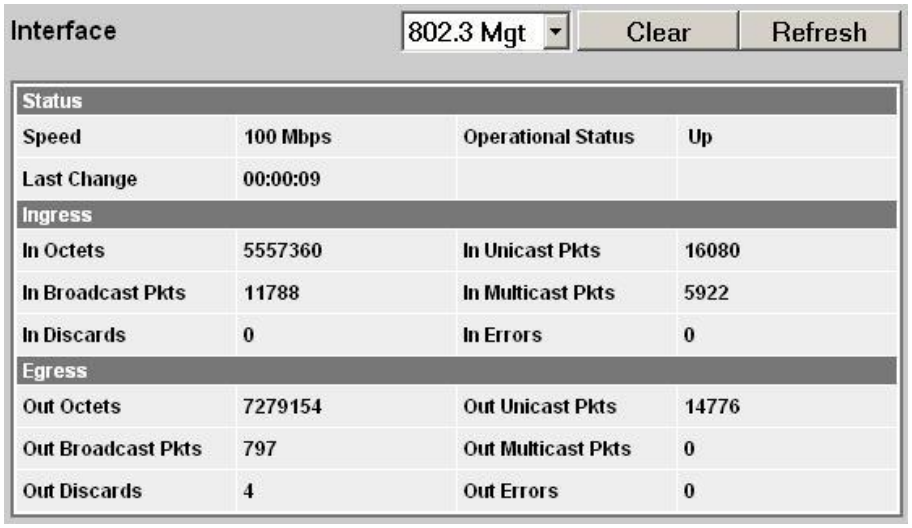

Figure 19: Web: Monitoring - Status - Wireless Statistics Screen

Interface: Click the arrow in the menu box to select the desired interface:

802.16 - Wireless interface.

802.3 Data - Data Ethernet port.

802.3 Mgmt - Management Ethernet port.

Clear: Click Clear to reset the 802.3 Data or 802.3 Mngt statistics on the selected interface. Does not affect the 802.16 wireless statistics.

Refresh: Click Refresh after changing the selected interface type, or anytime to display the latest statistics for the selected .

Status

Speed: Current speed of the interface (Mbps).

Operational Status: Display the current status of the wireless interface.

Up - Operational link to at least one subscriber.

Down - No operational links to subscribers.

Last Change: Time of the last change in the operational status or the wireless link.

Ingress

In Octets: Total number of good octets received.

In Unicast Pkts: Total number of received valid Ethernet frames with a unicast destination address.

In Not Unicast Pkts: Total number of received valid Ethernet frames with a multicast or broadcast destination address.

In Discards: Total number of valid Ethernet frames that are discarded due to lack of buffer space. This includes both frames discarded at ingress and frames discarded at egress due to priority and congestion at the output queues.

In Errors: Total number of Ethernet frames that are discarded because of invalid Frame Check Sequence (FSC).

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Egress

Out Octets: Total number of good octets transmitted.

Out Unicast Pkts: Total number of frames transmitted with a unicast Destination address.

Out Not Unicast Pkts: Total number of frames transmitted with a Multicast or Broadcast Destination address.

Out Discards: Total number of valid Ethernet frames that are discarded due to lack of buffer space. This counter is always 0 (all such discards are already counted in InDiscards).

Out Errors: Total number of packets that were transmitted with an invalid FCS.

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4.2.3 SS Info

Click **SS Information** in the menu (left side of screen) to view system information, Ethernet address settings, and wireless statistics for active subscribers.

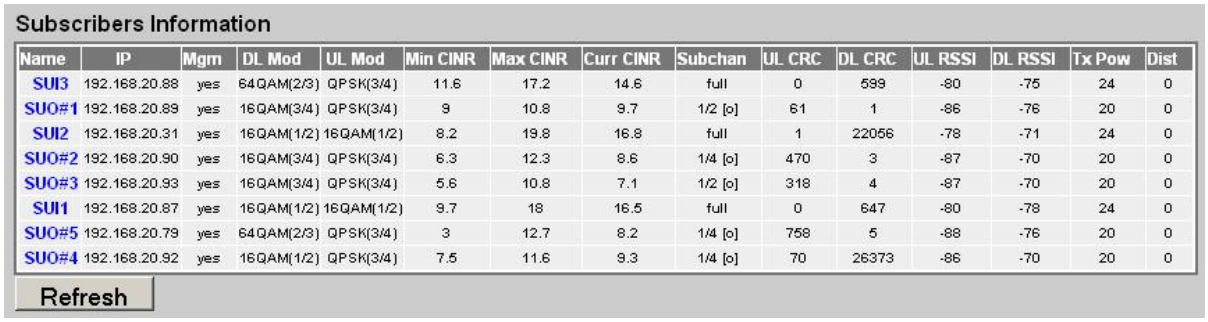

Figure 20: Web: Monitoring - AN-100UX SS Info Screen

SS Information

Name: User-assigned name for subscriber. Click on the subscriber name (blue text) to view the service flows settings and statistics.

IP: Secondary management channel (SMC) IP address for this subscriber.

Mgm: Indicates if the subscriber can be managed over the wireless interface. Refer to the subscriber user manual for additional information about enabling remote management.

yes: The subscriber supports remote management.

no: The subscriber can not be managed remotely.

DL Mod: Current modulation/coding setting for downlink channel. Displayed value is updated at one-minute intervals.

UL Mod:Current modulation/coding setting for uplink channel.

Curr CINR: The CINR value is continuously updated based on the last eight (8) frames.

Min CINR: Lowest calculated CINR value since last reboot. Displayed value is updated at one-minute intervals.

Max CINR: Highest calculated CINR value since last reboot. Displayed value is updated at one-minute intervals.

Subchan: (AN-100UX only) Indicates subscriber uplink mode. In standard mode uplink transmission (full) each subscriber uses a reserved time slot and transmits data using all subcarriers. When uplink subchannelization (USC) is indicated, one or more subscribers may transmit simultaneously, each transmitting on designated groups of subcarriers. When USC is mandatory [m] for a subscriber, all service flows on that subscriber are forced to Best Effort, and the modulation is limited to BPSK 1/2 or QPSK 1/2. Refer to the full description of this feature in section 7.1: Uplink Subchannelization (AN-100UX only) on page 113.

***Important**: Subscribers must be at software v2.1 or higher.*

full: Standard mode using all subcarriers (USC mode is not available).

1/2: 8 channel USC.

1/4: 4 channels USC.

1/8: 2 channels USC.

1/16: 1 channel USC.

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[o]: USC optional (may be used for bandwidth optimization).

[m]: USC mandatory to establish wireless link.

UL CRC: Total number of CRC errors detected in transmissions from this subscriber.

DL CRC: Total number of CRC errors reported by subscriber.

UL RSSI: Uplink RSSI (Received Signal Strength Indicator) value (dBm) measured by the base station is continuously updated based on the last eight bursts.

DL RSSI: Uplink RSSI value (dBm) measured by the subscriber is continuously updated based on the last sixteen (16) frames. Subscriber sends updated value at one-minute intervals.

Tx Pow: Reported transmit power for this subscriber. Subscriber sends updated value at one-minute intervals.

Dist: Calculated distance from base station to subscriber (kilometers).

Refresh: Click the Refresh button to update this screen with the latest values.

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SF Info

Click the subscriber name in the **SS Info** screen to view service flow statistics.

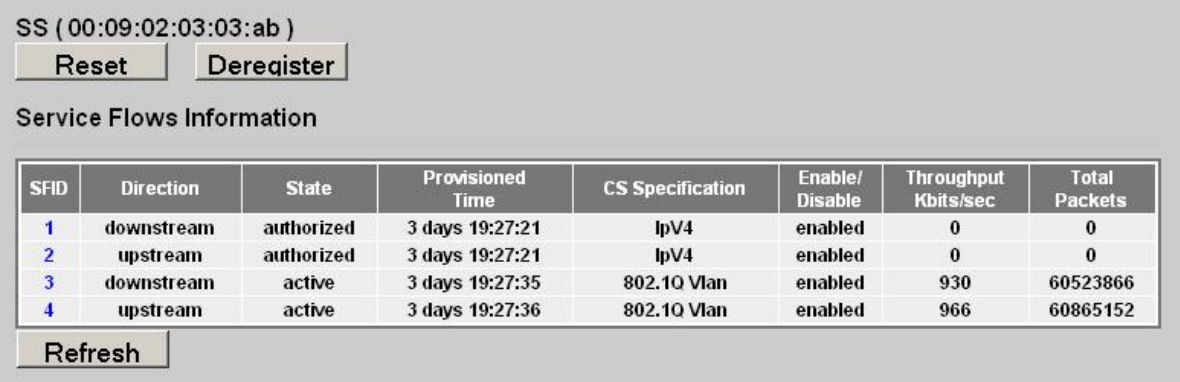
SS (00:09:02:03:03:ab)
Reset
Deregister
Service Flows Information
SFID | Direction | State | Provisioned Time | CS Specification | Enable/ Disable | Throughput Kbits/sec | Total Packets
1 | downstream | authorized | 3 days 19:27:21 | IpV4 | enabled | 0 | 0
2 | upstream | authorized | 3 days 19:27:21 | IpV4 | enabled | 0 | 0
3 | downstream | active | 3 days 19:27:35 | 802.1Q Vlan | enabled | 930 | 60523866
4 | upstream | active | 3 days 19:27:36 | 802.1Q Vlan | enabled | 966 | 60865152
Refresh

Figure 21: Web: Monitoring - SS Info - SF Info Screen

Service Flow Information

SFID: Service flow identifier for this service flow.

Direction: Direction of service flow:

Downstream: Downlink traffic from base station to subscriber.

Upstream: Uplink traffic from subscriber to base station.

State: Current state of the service flow.

Active: Service flow is currently active.

Admitted: Service flow is being edited or SC is setting up the service flow.

Authorized: Service flow configuration has been saved but is not active.

Rejected: Base Station was not able to setup the service flow.

Provisioned Time: Time elapsed since this service flow became active.

CS Specification: Classification type associated with this service flow.

802.3 Ethernet: Classified using fields in the Ethernet header.

802.1Q: Classified using fields in the Ethernet header and the 802.1Q VLAN tag.

IPv4: Classified using fields in the packet IP header.

IPv4 Over 802.3 Ethernet: Classified using fields in the packet's IP header and the Ethernet header.

IPv4 Over 802.1Q: Classified using fields in the packet's IP header, the Ethernet header, and the 802.1Q VLAN tag.

Enable/Disable: Indicate the operator-selected status for this service flow:

Enabled: Service flow is enabled.

Disabled: Service flow is disabled.

Throughput Kbits/sec: Traffic throughput rate for this service flow.

Total Packets: Total packets exchanged with the subscriber (all service flows).

Controls

Reset: Click [Reset] to reboot the subscriber MAC (subscriber will be deregistered).

Deregister: Click [Deregister] to force the subscriber to be deregistered (no reboot).

Refresh: Click [Refresh] to update the screen with the latest totals.

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4.2.4 Event Log

Click **Event Log** in the menu (left side of screen) to view system activity and log messages. Refer to the RedMAX Administration and Maintenance Guide for additional details.

Fri Nov 21 19:13:40	SS Registered: SUO#2
Fri Nov 21 19:13:40	SBC Success: SUO#2
Fri Nov 21 19:13:40	Subchannelized Initial Ranging Success: SUO#2
Fri Nov 21 19:13:36	SS Registered: SUO#1
Fri Nov 21 19:13:36	SBC Success: SUO#1
Fri Nov 21 19:13:36	Subchannelized Initial Ranging Success: SUO#1
Fri Nov 21 19:13:17	NOTICE: Default Uplink Service Flows are Disabled
Fri Nov 21 19:13:17	Average Noise Floor in the Uplink Channel = -105.5 dBm

Figure 22: Web: Monitoring - Event Log Screen Example

4.2.5 Auto Refresh

Click **Auto Refresh** in the menu (left side of screen) to view and modify the periods used to automatically refresh the listed web screens.

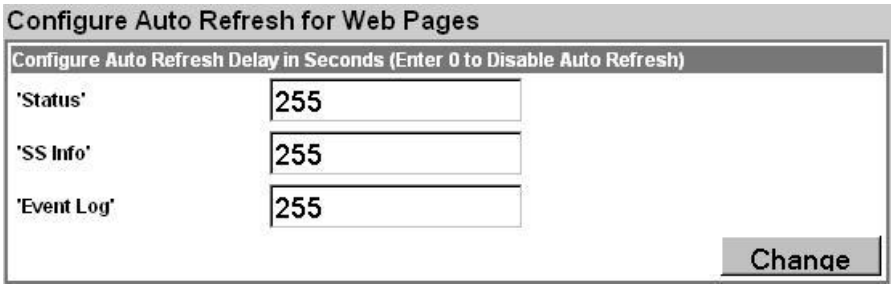

Figure 23: Web: Monitoring - Auto Refresh Screen

Status: Set the automatic refresh period (seconds) for the Status screen.

SS Info: Set the automatic refresh period (seconds) for the SS Info screen.

Event Log: Set the automatic refresh period (seconds) for the Event Log screen.

Change: Click Change to update the screen with the latest totals.

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4.3 Creating Service Flows - Overview

There are four steps associated with creating service flows:

Note: A service class can not be deleted until all provisioned/active service flows referencing this service class have been deleted.

1. Create service class.

   Each service class defines a set of QoS parameters that can be associated with a service flow. Multiple service class definitions can be added to create a library of service classes. By creating a set of standardized service classes, new service flows can be added that conform to pre-defined service level agreements (SLAs). Each service class definition includes traffic rates, latency settings, priority, and transmission policy settings.

2. Create service flow.

   All service flows are based on existing service class definitions. Separate service flows are required for downlink and uplink traffic. Each definition requires identifying the subscriber (by name or MAC address), flow direction, class of service, and the classifier type.

3. Define classifier.

   A unique set of classifier rules can be defined for each service flow, depending on the classification type (i.e., Packet, 802.3/Ethernet) selected when the service flow is created. All associated classifiers are deleted when the service flow is deleted.

4. Activate

   A new service flow is not activated until a classifier is assigned (click **Add** in the Classifier screen).

   If the target subscriber is registered a Dynamic Addition Session (DSA) session is initiated. During a DSA session, the service flow is in Requesting state. If the DSA session is successful, the state is set to Active. If the DSA session is not successful, the state is set to Rejected.

   If the target subscriber is not registered, the service flow request is stored until the associated subscriber is registered. The subscriber registration triggers the activation of all associated service flows.

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4.3.1 Subscribers

Click **Subscribers** in the menu (left side of screen) to view a summary of the subscribers currently configured on the base station.

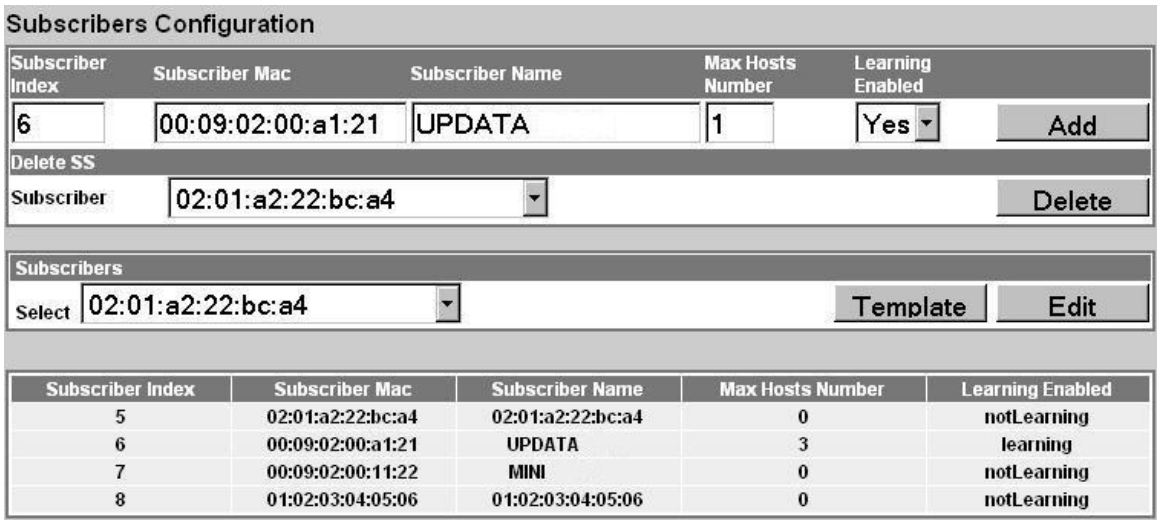

Figure 24: Configuration - Subscribers Configuration Screen

Subscriber Index: Unique index number to identify this subscriber. This number is generated automatically by the base station. The user can also specify an index number (must be unique) when creating a new subscriber entry.

Subscriber MAC: MAC address of the subscriber. You must enter this information when creating a new subscriber entry.

Subscriber Name: Enter the name for this subscriber. This reference is displayed when managing service flows and classifiers.

Max Hosts Number: Enter the maximum number of hosts (device MAC addresses) to discover on the Ethernet interface to this subscriber. Valid only if Learning Enabled=Yes.

Learning Enabled: The MAC learning feature allows the base station to automatically learn up to 256 hosts (devices) on the Ethernet segment connected to a subscriber. This feature can be enabled and disabled individually for any subscriber.

No: Auto-learning is disabled for this subscriber.

Yes: Auto-learning is enabled for this subscriber. See the following requirements:

Generic Classifiers: To use MAC auto-learning feature, it is necessary to create a downlink service flow and assign a generic classifier. The service flow identifies the traffic type and the generic classifier provides a template for automatically adding classifiers for identified hosts. The host-specific classifiers are deleted automatically whenever the subscriber de-registers.

Important: When learning is disabled, generic classifiers function as pass-all filters. In a PMP scenario, this may cause all downlink traffic to be forwarded only to a single subscriber or a subset of subscribers.

To avoid traffic instability:

1. Enable learning before adding generic classifiers to the DL service flow.
2. Disable learning only after deleting the generic classifiers.

For more information, refer to section 4.3.4: Classifiers on page 59

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MAC Learning Table

The subscriber and base station do not use 'MAC aging' and each learned host address remains in the learning table until the subscriber is rebooted. Causing the subscriber to re-register with the base station does not clear the subscriber learned MAC address table. Reboot the subscriber to clear the MAC table and rediscover active hosts on the Ethernet segment connected to a subscriber.

Add: Click Add to create a new subscriber listing. This control is active only when a new MAC address has been specified in the Subscriber MAC field. When adding new subscribers, the MAC learning feature is enabled by default and the host number is set to one (1). Refer to the Learning Enabled feature above for details.

Delete SS

Subscriber: Select the name of the subscriber to be deleted.

Delete: Click Delete to deactivate and remove all classifiers and service flows for this subscriber. The subscriber will be removed from the subscribers list.

Subscribers

Select: Use this field to select the name of the subscriber to be viewed, edited, or used as a template for creating a new subscriber entry.

Template: Select a subscriber and click Template to display the current settings in the upper portion of the screen. These settings can be modified and used to create a new subscriber entry. Click Add to create the new subscriber entry.

Edit: Select a subscriber and click Edit to display the current settings the upper portion of the screen. These settings for this subscriber can now be modified. Click Modify .to save changes to this subscriber entry. You can not modify the index number for a subscriber.

Important: Modifying an existing subscriber will cause the base station to delete and recreate all service flows and classifiers for this subscriber.

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4.3.2 Service Classes

Click **Service Classes** in the menu (left side of screen) to view, add, or delete service class definitions. The base station will guarantee the QoS parameters for service flows created referencing this service class.

Multiple service class definitions can be created to build a library of service classes. A service class can not be deleted until all provisioned/active service flows referencing this service class are deleted.

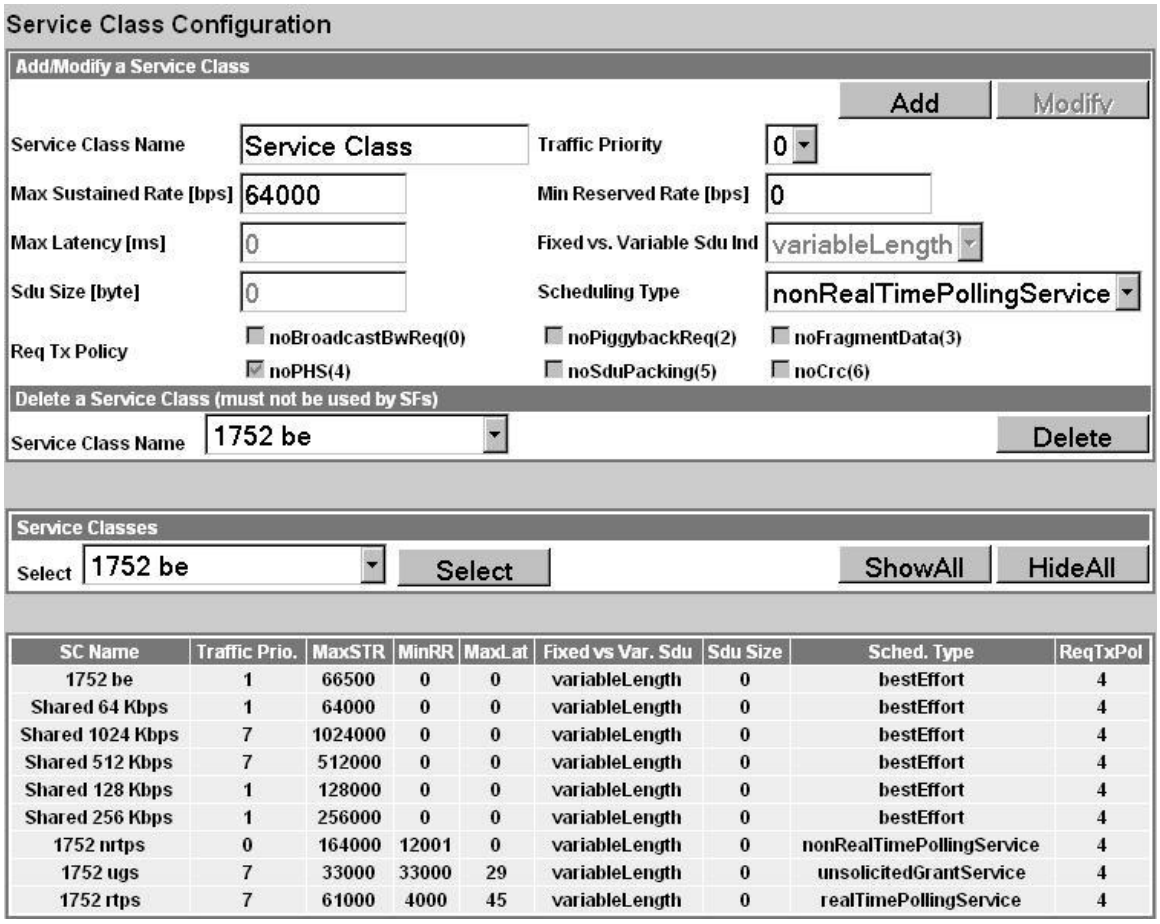
Service Class Configuration
Add/Modify a Service Class
Add
Modify
Service Class Name
Service Class
Traffic Priority
0
Max Sustained Rate [bps]
64000
Min Reserved Rate [bps]
0
Max Latency [ms]
0
Fixed vs. Variable Sdu Ind
variableLength
Sdu Size [byte]
0
Scheduling Type
nonRealTimePollingService
Req Tx Policy
noBroadcastBwReq(0)
noPiggybackReq(2)
noFragmentData(3)
noPHS(4)
noSduPacking(5)
noCrc(6)
Delete a Service Class (must not be used by SFs)
Service Class Name
1752 be
Delete
Service Classes
Select
1752 be
Select
ShowAll
HideAll
SC Name | Traffic Prio. | MaxSTR | MinRR | MaxLat | Fixed vs Var. Sdu | Sdu Size | Sched. Type | ReqTxPol
1752 be | 1 | 66500 | 0 | 0 | variableLength | 0 | bestEffort | 4
Shared 64 Kbps | 1 | 64000 | 0 | 0 | variableLength | 0 | bestEffort | 4
Shared 1024 Kbps | 7 | 1024000 | 0 | 0 | variableLength | 0 | bestEffort | 4
Shared 512 Kbps | 7 | 512000 | 0 | 0 | variableLength | 0 | bestEffort | 4
Shared 128 Kbps | 1 | 128000 | 0 | 0 | variableLength | 0 | bestEffort | 4
Shared 256 Kbps | 1 | 256000 | 0 | 0 | variableLength | 0 | bestEffort | 4
1752 nrtps | 0 | 164000 | 12001 | 0 | variableLength | 0 | nonRealTimePollingService | 4
1752 ugs | 7 | 33000 | 33000 | 29 | variableLength | 0 | unsolicitedGrantService | 4
1752 rtps | 7 | 61000 | 4000 | 45 | variableLength | 0 | realTimePollingService | 4

Figure 25: Configuration - Service Class Screen

Service Class Configuration Screen

Add a Service Class

Service Class Name: Enter a name for this service class. The name can be any combination of up to 30 letters and numbers.

Traffic Priority: Enter the priority to be used for service flows created using this service class. The priority is relative only to other service flows on the same subscriber. The value '7' represents the highest priority.

Note: This is not the Ethernet (802.1p) priority setting.

Max. Sustained Rate (bps): Enter the maximum sustained wireless transmission rate (metered over a one second sliding window) for service flows created using this service class. This is also the peak data rate. If higher bursts are experienced, the scheduler will be unable to forward all received data in the current wireless frame and buffer overflow will occur (Max. Sustained Rate / Frame Rate).

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Min. Reserved Rate (bps): Enter the minimum wireless transmission rate for service flows created using this service class.

Max Latency (ms): Enter the maximum latency allowed when forwarding packets from the Ethernet port to the wireless interface. Service flows created using this service class are guaranteed to have latency of less than or equal to this setting.

Fixed Vs. Variable Sdu Ind: Specify if all Ethernet packets will be variable sizes or fixed length. Selecting fixedLength allow the base station to utilize the wireless bandwidth more efficiently .

fixedLength: All Ethernet packets are the same size.

variableLength: Ethernet packets are variable sizes.

Sdu Size: Enter the size for fixed length Ethernet packets. Enabled only if fixedLength is selected in **Fixed vs. Variable Sdu Ind** field.

Scheduling Type: Select the type of scheduling service.

bestEffort: (BE) For applications that do not require a minimum bandwidth allocation. Required settings are:

Max. Sustained Rate: PIR

Traffic Priority: 0-7

nonRealTimePollingServices: (nrtPS) For applications requiring variable-sized SDUs transmitted at a minimum sustained data rate. Required settings are:

Traffic Priority: 0-7

Max. Sustained Rate: PIR

Min. Reserved Rate: CIR

realTimePollingServices: (rtPS) For applications requiring variable-size SDUs transmitted at regular intervals. Required settings are:

Max. Sustained Rate: PIR

Min. Reserved Rate: CIR

Max. Latency: Enter requirement in milliseconds.

unsolicitedGrantService: (UGS) For applications requiring fixed-length data packets issued at regular periods. Priority is defined by the order of creation. Required settings are:

Max. Sustained Rate: Required throughput (add 5% overhead for uplink only).

Max. Latency: Not used for downlink connections. Downlink UGS traffic is included in every wireless frame. For uplink connections, it is used to specify the grant interval.

Uplink UGS grants are calculated as follows:

Bandwidth = Max Sustained Rate * Max. Latency

Interval = Max. Latency (milliseconds)

Req Tx Policy: Check ☑ items to configure the transmission policy. Selecting a control inhibits the specified operation:

noBroadcastBwReq(0): Do not broadcast bandwidth requests.

noPiggybackRequest(2): Do not piggyback bandwidth requests.

noFragmentData(3): Do not fragment Ethernet packets.

noPHS(4): Do not support payload header suppression.

noSduPacking(5): Do not pack multiple Ethernet packets in a wireless MAC packet.

noCRC(6): Do not attach the CRC field to the end of a Wireless MAC packet.

Add: Click Add to create a new service flow definition.

Modify: Click Modify to change the service class definition.

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Note: Changing a service class definition will interrupt traffic on referencing service flows until they have become active again.

Delete a Service Class

Service Class Index: Select an existing service class.

Delete: Click [Delete] to delete the selected service class definition.

View Service Class

Service Class Index: Select an existing service class.

Select: Click [Select] to display the selected service class definition.

ShowAll: Click [ShowAll] to display all service class definitions.

HideAll: Click [HideAll] to not display any definitions.

SC Name: Name of service class.

Traffic Prio.: Priority setting (relative to other service flows on the same subscriber).

MaxSTR: Maximum sustained traffic rate setting.

MinRR: Minimum reserved rate setting.

MaxLat: Maximum latency setting.

Fixed Vs Var.Sdu: Format for SDU.

Fixed: Variable length SDU's are allowed.

Variable: Only fixed length SDU's are allowed.

SduSize: Size of SDU (if fixed)

SchedType: Scheduling type for this service class.

ReqTxPol: List of enabled transmit policies. Number 4 (representing enabled noPHS) will always be in the list. If a user, for example, checks noSduPacking checkbox then the number 5 will also be in the list. Note that number 6 will never be in the list as the noCRC checkbox cannot be selected.

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4.3.3 Service Flows

Click **Service Flows** in the menu (left side of screen) to view, add, and delete service flows. Service flows provide the ability to set up multiple uplink and downlink connections to each subscriber in a sector, and each service flow may be assigned a unique service level category and separate QoS settings. A service flow is not fully activated until at least one classifier is assigned.

Default UL/DL Service Flows

The default service flows are used to pass traffic not matching any user-defined service flow (such as broadcast ARP) between the base station and subscribers.

The default uplink service flow can be disabled. Refer to the **Default Service Flows** fields (section 4.5.1: Advanced Config on page 73) or the CLI command **DefaultUlSfEnable** (Table 38: CLI - Interfaces Command: wireless on page 94).

The downlink default service flow is permanently enabled. The maximum rate can be specified and the MAC address of the aggregator. Only traffic received from the specified aggregator is forwarded to subcribers. Refer to section 4.5.1 Advanced Config on page 73).

Default service flow traffic is aggregated with statistics for all other uplink and downlink service flows. The default service flows and classifiers must be included when calculating the total service flows and classifiers for a sector.

Table 25: System - Default Service Flow Throughput

Channel	Max Throughput*	Description
Downlink	User Configurable	Bandwidth is shared by all registered subscribers. Service flow is always enabled.
Uplink	8 Kbps / subscriber	Bandwidth allocated per registered subscriber. Service flow can be enabled/disabled for entire sector (requires sector controller to be rebooted). Must be enabled for IP-based classification.

*FIFO operation - all packets exceeding these rates are discarded.

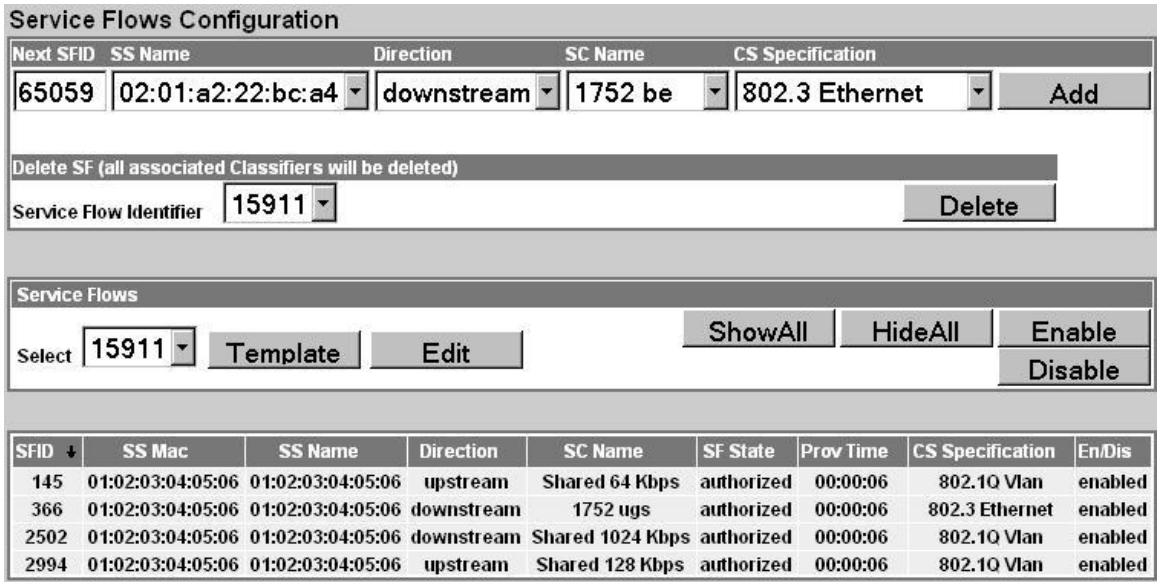

Figure 26: Configuration - Service Flow Screen

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Add Service Flow

Next SfId: This identifier value is assigned to the next new service flow.

SS Name: Name of subscriber associated with this service flow.

Direction: Direction of service flow. Separate service flows are required for upstream and downstream traffic.

Downstream: Downlink traffic from a base station to a subscriber.

Upstream: Uplink traffic from a subscriber to the base station.

SC Name: Select the service class definition for this service flow.

Cs Specification: Convergence sublayer encapsulation type associated with this service flow.

802.3 Eth: The classifiers for this service flow are based on the combination of fields in the Ethernet header.

802.1Q VLAN: The classifiers for this service flow are based on the combination of the fields in the Ethernet header and 802.1Q VLAN tag.

IPv4: The classifiers for this service flow are based on the IPv4 IP header.

IPv4 Over 802.3: The classifiers for this service flow are based on the combination of fields in the IPv4 header and the Ethernet header.

IPv4 Over 802.1Q: The classifiers for this service flow are based on the combination of fields in the IPv4 header and the 802.1Q VLAN tag.

Add (Modify): Click Add to create a new service flow definition using the current settings. This control is also displayed as Modify after clicking Template or Edit.

Note: Service flows can be activated only after the requested configuration is validated and saved. See 4.3.5: Manage -- Save Provisioning Information *on page 64.*

Delete SF (and Classifiers)

Service Flow Identifier: Unique index number of the service flow to be deleted.

Delete: Click Delete to delete the selected service flow (and all associated classifiers).

Note: If the subscriber using this service flow is not registered, the service flow is deleted immediately. If the subscriber is registered, a Dynamic Service Deletion (DSD) session is initiated to delete the service flow. The service flow is deleted when the subscriber sends acknowledgement or becomes deregistered.

Service Flows

Select: Select the unique index number for the service flow to display.

Template: Click Template to modify any field for the selected service flow. Clicking Edit changes in the fields adjacent to the Modify button (top of screen).

Edit: Click Edit to change only the service class associated with this service flow.

ShowAll: Click ShowAll to display settings for all service flows.

HideAll: Click HideAll to hide the settings for all service flows.

Enable: Click Enable to enable this service flow (will be provisioned to active).

Disable: Click Disable to disable this service flow (will not be provisioned).

Service Flow Status Display

Left-click the mouse on the heading for any column to sort the table using that selection.

SFID: Unique index number assigned when this service flow was created. This number is required when creating a classifier for the service flow (classifier configuration screen).

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SS MAC: MAC address of the subscriber associated with this service flow.

SS Name: User-assigned name for the subscriber associated with this service flow.

Direction: Indicates the direction assigned to the service flow.

Downlink: The direction of data traffic is towards the subscriber.

Uplink: The direction of data traffic is from the subscriber.

SC Name: Name of the service class definition associated with this service flow (hover mouse pointer over name to display service class index number).

Sf State: Current status of the service flow.

Authorized: Service flow configuration has been saved but is not active.

Admitted: Service flow is being edited or SC is setting up the service flow.

Active: Service flow is currently active.

Rejected: Base Station was not able to setup the service flow.

Provisioned Time: Time stamp of when an action was last performed on the service flow. This time stamp is displayed in hours, minutes, and seconds (hh:mm:ss) relative to when the base station was rebooted. If required, the absolute time and day of an event can be determined using the Time Since System Restart on the General Information page:

Current Time - (Time Since System Restart - Provisioned Time)

Note: A value of '00:00:00' indicates that the service flow was created before the base station was rebooted, and the service flow has not been activated.

Cs Specification: Convergence sublayer encapsulation type associated with this service flow. Refer to section 4.3.4: Classifiers on page 59 for supported classification types.

Enable/Disable: Displays the current state of the service flow:

Enabled: Service flow is provisioned by the base station.

Disabled: Service flow will not be provisioned by the base station.

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4.3.4 Classifiers

Click **Classifiers** in the menu (left side of screen) to view, add and delete service flow classifiers. Any active service flow must have at least one active classifier. The 802.16 Service Flow can have multiple classifiers (classification rules). New classifiers become active after clicking **Add** on this screen.

When multiple classifiers are defined for one service flow, the index number is listed in the form X.Y where:

X == Service Flow index (SfId)

Y == Classifier index number

When a service flow is activated, the classifiers become active by default. A service flow can have both active and inactive classifiers only when the service flow is already *active* and new classifiers are added. New classifiers become active only after they are successfully implemented on both the base station and the subscriber.

Important Information About Using Generic Classifiers

What is a Generic Classifier

A generic classifier is defined as any classifier with only the priority field enabled.

Behavior of Generic Classifiers

It is important to note that generic classifier filters behave differently based on the mode of the learning function. See the following table.

Table 26: System - Generic Classifier Functions

Learning Enabled	Filtering Function
Yes	A service flow and a generic classifier must be created for each subscriber using the learning function. The generic classifier functions as a template. When a new host is detected, the learning function automatically adds a new host-specific classifier (based on the generic classifier definition) to the associated downlink service flow. These host-specific classifiers are deleted automatically when the subscriber de-registers.
No	The generic classifiers must be deleted when before Learning is disabled. When Learning is disabled, the generic classifier functions as a pass-all filter and all downlink traffic in the sector that does not match any higher priority classifier will be directed to that downlink service flow. This may cause all downlink traffic to be forwarded only to a single subscriber or subset of subscribers.

Using the Learning Feature

To use the Learning feature (Learning Enabled = Yes) for any subscriber, it is necessary to create a downlink service flow and assign a generic classifier. When a new host is detected by the subscriber, this is reported to the base station and the learning function automatically adds a new classifier to permit downlink traffic to that host. The generic classifier filters traffic based on the service flow type:

802.3 Eth: The classifiers for this service flow are based on the combination of fields in the Ethernet header.

802.1Q VLAN: The classifiers for this service flow are based on the combination of the fields in the Ethernet header and 802.1Q VLAN tag.

IPv4: The classifiers for this service flow are based on the IPv4 IP header.

IPv4 Over 802.3: The classifiers for this service flow are based on the combination of fields in the IPv4 header and the Ethernet header.

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IPv4 Over 802.1Q: The classifiers for this service flow are based on the combination of fields in the IPv4 header and the 802.1Q VLAN tag.

To avoid unwanted behavior, it is necessary to set Learning Enabled = Yes before adding generic classifiers.

Changing the Learning Mode

When Learning Enabled is set to 'No' on a subscriber, all generic classifiers on active service flows on that subscriber will begin to operate as pass-all filters -- directing all same/lower priority downlink traffic in the sector to that subscriber.

It is recommended to use the following procedure when disabling the MAC auto-learning function for any subscriber:

1. Identify the subscriber to be modified (Learning Enabled = Yes).
2. Identify the downlink service flow(s) associated with this subscriber.
3. Take the following action:
    a) Delete the service flows that have generic classifiers, or
    b) Delete the generic downlink classifier associated with each service flow
4. Go to the subscriber screen and set Learning Enabled = No (subscriber will re-register).

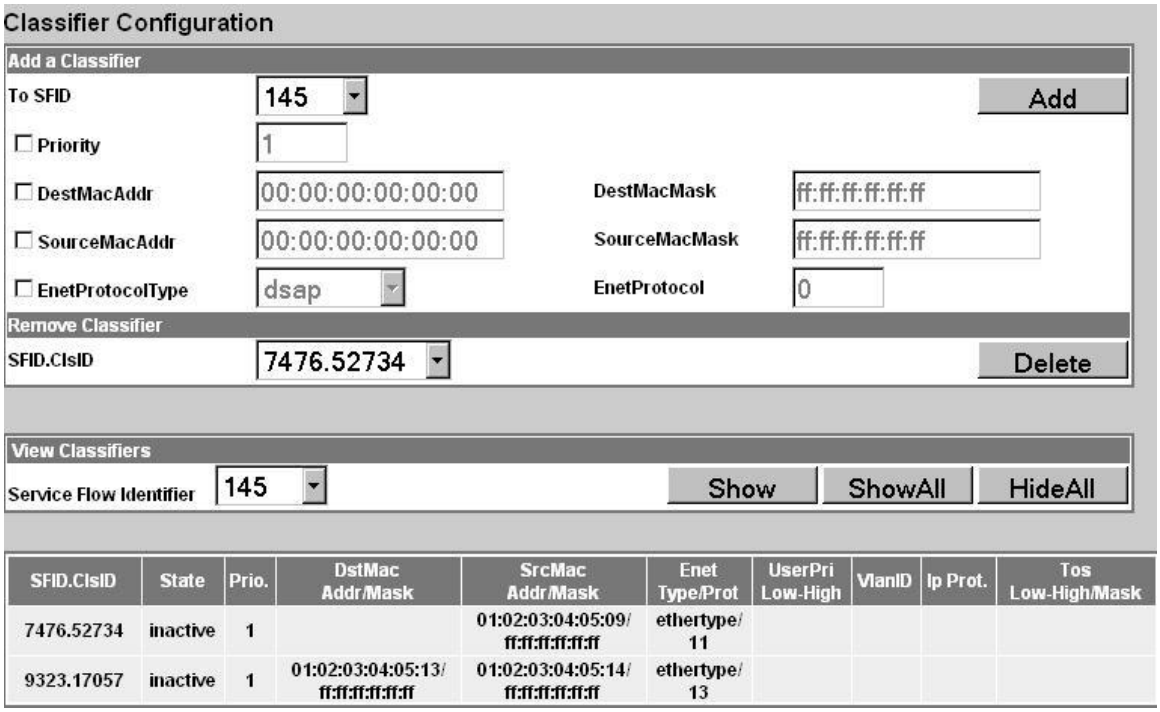

Figure 27: Configuration - Classifier Screen

Classifier Configuration Screen

Add a Classifier

To SFID: Select the index number of the service flow. Refer to the Service Flows Configuration screen for a list of all service flows.

Priority: Check ☑ to set a priority for this classifier. When a packet can be classified by more than one classifier definition, it is classified according to the classifier with the highest priority setting. Enter a priority value from 0 to 255 (highest priority).

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Packets are tested beginning with the classifier definition having the highest priority value. The packet is processed based on the first discovered match. If classifiers have equal priority, the order of evaluation can not be predicted.

DestMacAddr: Check ☑ to enable classification based on a destination MAC address (downstream traffic from the base station). Enter the MAC address in the adjacent field. When matched, downlink traffic is sent from the base station using the associated service flow.

DestMacMask: Enter the mask value (hex) to be used with the destination MAC address (DestMacAddr). Valid only if the DestMacAddr is enabled (☑). For examples:

1. A mask value of all ones (ff:ff:ff:ff:ff:ff) will match only the MAC address entered in the DestMacAddr field.

2. A partially specified mask value will match a range of MAC addresses. For example, a mask value of 01:02:03:ff:ff:ff will match all MAC addresses where the first 48 bits are 01:02:03. The DestMacAddr should be set to all zeros.

3. A mask of all zeros (00:00:00:00:00:00) will match all destination MAC addresses (DestMacAddr field is ignored). All downlink traffic in the sector that does not match any higher priority classifier is directed to the downlink service flow with this classifier. *Only one classifier in a sector can have a DestMacMask value set to all zeros.* This is not equivalent to a generic classifier used for MAC Learning.

Important: The feature to set a DL service flow classifier MAC address mask to all zeros (00:00:00:00:00:00) is provided only to enable pass-all operation for PTP backhaul. Use in a PMP scenario may cause all downlink traffic to be forwarded only to a single subscriber or subset of subscribers. Refer to section 7.6: RedMAX Backhaul Application on page 123 for details.

SourceMacAddr: Check ☑ to enable classification based on a source MAC address (upstream traffic to the base station). Enter the MAC address in the adjacent field. When matched, uplink traffic is sent from the subscriber using the associated service flow.

SourceMacMask: Enter the mask value (hex) to be used with the source MAC address (SourceMacAddr).

1. A mask value of all ones (ff:ff:ff:ff:ff:ff) will match only the MAC address entered in the SourceMacAddr field.

2. A partially specified mask value will match a range of MAC addresses. For example, a mask value of 01:02:03:ff:ff:ff will match all MAC addresses where the first 48 bits are 01:02:03. The SourceMacAddr should be set to all zeros.

3. A mask of all zeros (00:00:00:00:00:00) will match all source MAC addresses (SourceMacAddr value is ignored). All downlink traffic in the sector that does not match any higher priority classifier is directed to the downlink service flow with this classifier. *Only one classifier in a sector can have a SourceMacMask value set to all zeros.* This is not equivalent to a generic classifier used for MAC Learning.

Important: The feature to set a DL service flow classifier MAC address mask to all zeros (00:00:00:00:00:00) is provided only to enable pass-all operation for PTP backhaul. Use in a PMP scenario may cause all downlink traffic to be forwarded only to a single subscriber or subset of subscribers. Refer to section 7.6: RedMAX Backhaul Application on page 123 for details.

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EnetProtocolType: Check ☑ to enable classification based on the protocol transported by Ethernet. Select Ethernet type from the list: Ethertype for Ethernet version 2 and 802.3 SNAP, and DSAP for 802.3 LLC.

EnetProtocol: Enter the identifier of the protocol transported by Ethernet. Valid only if an EnetProtocolType is selected. Valid Ethertype values are from 1,501-65,536. Valid DSAP values are from 0-169 and 171-255. For example, in order to allow IP traffic, set EnetProtocolType to Ethertype and EnetProtocol to 2048 (0800 hex).

A list of Ethertypes can be found at:

http://www.iana.org/assignments/ethernet-numbers

A list of DSAP values can be found at:

http://www.ethermanage.com/ethernet/enet-numbers/ieee-lsap-list.html.

Add: Click [Add] to save the classifier settings.

Note: Classifier settings are effective immediately when created.

Remove Classifier

Service Flow Identifier: Select an existing classifier to be deleted. The format is:

Service Flow ID. Classifier ID

Delete: Click [Delete] to permanently delete the selected classifier.

View Classifiers

SFID.ClsID: Identifiers for the selected classifier. The format is:

Service Flow ID. Classifier ID

Show: Click [Show] to display the setting for the service flow selected in the Service Flow Identifier field.

ShowAll: Click [ShowAll] to display settings for all service flows.

HideAll: Click [HideAll] to hide settings for all service flows.

Classifier Table

SFID.ClsID: Identifiers for the selected classifier. The format is:

State: Current state of the service flow:

Active: Classifier is currently active.

Inactive: Classifier is not currently active.

Prio: Priority setting for this classifier.

DestMac: When displayed, classification is based on this destination MAC address.

Addr: Destination MAC address.

Mask: Destination MAC mask.

SrcMac: When displayed, classification is based on this source MAC address.

Addr: Source MAC address.

Mask: Source MAC mask.

Enet Type/Prot: When displayed, classification is based on Ethernet protocol type and protocol.

UserPri: Matching parameters for the Ethernet IEEE 802.1D user priority value (Ethernet packets with 802.1Q encapsulation). A packet will match if the priority setting is equal to, or falls between, the high and low range setting. Valid settings are zero to seven (0 to 255).

Low: Lowest priority setting of range.

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High: Highest priority setting of range.

VlanID: Ethernet packet 802.1Q VLAN tag. Valid only if Cs Specification is 802.1Q.

Ip Prot.: IPv4 specification. Valid only if the service class Cs Specification is IPv4.

EnetProtocol: When displayed, classification is based on this Ethernet protocol.

Tos: Matching parameters for the IP type of service/DSCP (IETF RFC 2474). An IP type of service (ToS) packet will match if the "ip-tos" value, after the mask is applied, is equal to, or falls between, the high and low range setting. Valid settings are 0 to 255.

Low: Lowest priority setting of range.

High: Highest priority setting of range.

Mask: A logical 'AND' is performed using the mask and the "ip-tos" value before testing for range.

SrcIp: Source IPv4 address. Valid only if Cs Specification is IPv4.

Addr: Source IPv4 address network mask.

Mask: Source IPv4 address network mask.

DstIp: IPv4 destination address. Valid only if Cs Specification is IPv4.

Addr: Destination IPv4 address network mask.

Mask: Destination IPv4 address network mask.

DstIp: IPv4 destination address.

Addr Mask: Valid only if Cs Specification is IPv4.

SrcPort: Source IPv4 address port. Valid only if Cs Specification is IPv4.

Start: Lowest port address in range.

End: Highest port address in range.

DstPort: IPv4 destination port address. Valid only if Cs Specification is IPv4.

Start: Lowest port address in range.

End: Highest port address in range.

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4.3.5 Manage -- Save Provisioning Information

Click **Manage** in the menu (left side of screen) to determine if there are unsaved changes to the service classes, service flows, or classifiers.

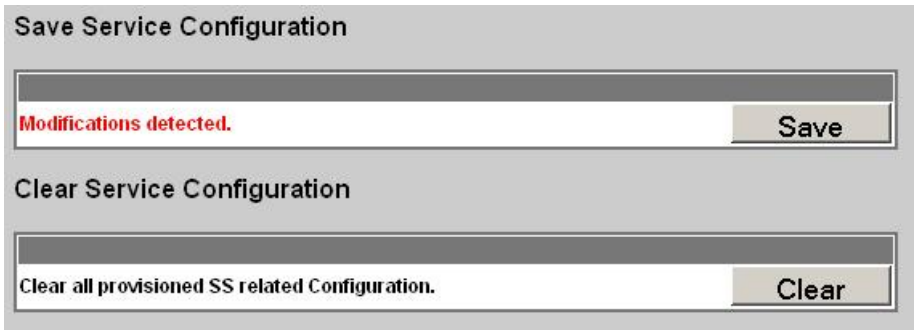

Figure 28: Configuration - Save SF Configuration Screen

Save Provisioning Configuration

Save Provisioning Configuration: This screen indicates if there are unsaved changes to service classes, service flows, or classifiers.

No Modifications Detected: There are no unsaved changes.

Modifications Detected: There are unsaved changes.

Save: Click [Save] to save all changes. Saving changes will copy all service class, service flow, classifier configuration data, and subscriber database information to non-volatile memory. When the base station is rebooted, all unsaved changes to the service classes, service flows, and classifiers are discarded.

The [Save] control is active only if there are unsaved changes to service classes, service flows, or classifiers.

Clear Provisioning Configuration

Clear Provisioning Configuration: Clear all service flow configuration data.

Clear: Click [Clear] to remove all changes made since the last save.

Note: The Clear Provisioning Configuration feature is not activated in this software release.

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4.4 Interface Configuration

View and modify the base station settings for the wireless, Ethernet, and management interfaces.

4.4.1 Wireless Interface

Click **Wireless Interface** in the menu (left side of screen) to view and modify the base station MAC, PHY, and RF wireless settings.

Note: Changes to settings marked with a red asterisk (*) are only effective after clicking Save *and rebooting the base station.*

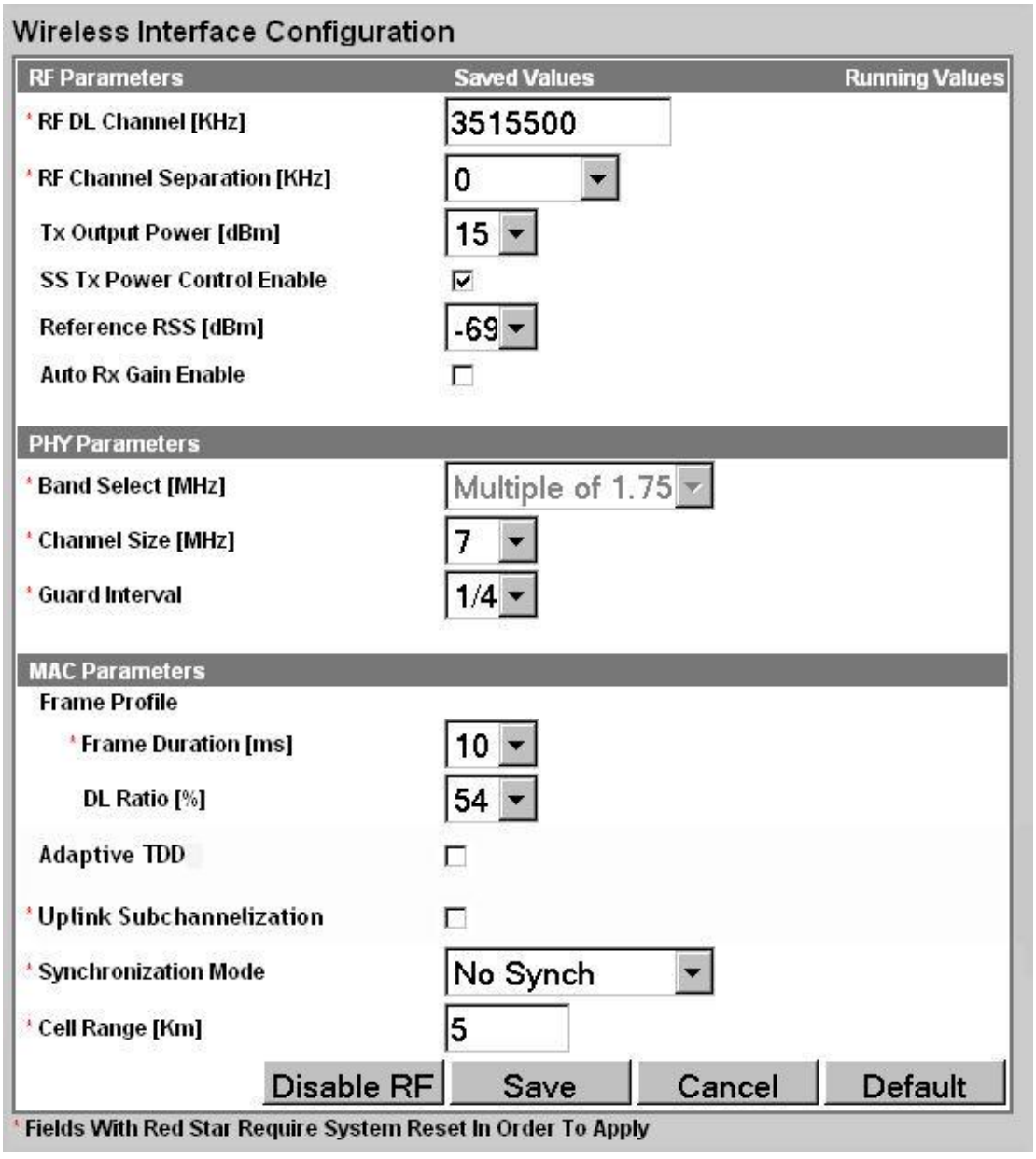

Figure 29: Web: Configuration - Wireless Interface Screen

RF Parameters

RF DL Channel KHz: (*) Enter the channel frequency to use for all subscribers in the sector. The setting is validated against the type of radio installed. The center frequency

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setting can be made in steps of 250 KHz, and the center frequency setting must allow for the channel size and not exceed the granted frequency range. For example, when using a 7 MHz channel, the center frequency must be at least 3.5 MHz inside the band limits.

***Important*: RF Channel Settings:** *Operation in the FWA band is subject to license. The radio frequency selections must be set correctly before the installed system is allowed to transmit. The installed system must comply with all governing local, regional, and national regulations. Contact authorities in the country of installation for complete information regarding the licensing regime and operating restrictions for that regulatory domain.*

RF Channel Separation KHz: (*) Select the separation between channels (HD-FDD radio only) where: UL Channel = DL Channel + Separation.

Tx Output Power dBm: Select the output power level (dBm) of the radio.

Table 27: System - Tx Power Settings (dBm)

Equipment	Minimum	Maximum
AN-100U	0	23
AN-100UX	20	36*

* For best AN-100UX wireless link performance, it is recommended to use a maximum setting of 35 DBm when operating at 64 QAM.

***Important*: RF Power Settings:** *Operation in the FWA band is subject to license. The radio power selections must be set correctly before the installed system is allowed to transmit. National Interface documents may identify a maximum output power for the wireless system, expressed in terms of an EIRP level that must not be exceeded. The installed system must comply with all governing local, regional, and national regulations. Contact authorities in the country of installation for complete information regarding the licensing regime and operating restrictions for that regulatory domain.*

SS Tx Power Control Enable: Check ☑ to allow the base station to automatically adjust the transmit power level of subscribers. When enabled, the base station continually monitors the subscribers and adjusts the transmission power to maintain a requested RSSI value.

Reference RSS: Select the target value for average Received Signal Strength (RSS) for subscribers. The Reference RSS setting is the target value for average Received Signal Strength (RSS) for subscribers RF signals received by the base station. This target value allows automatic adjustment of the subscriber Tx power for optimum performance with the minimum of RF interference. The suggested default setting values are indicated in the following table:

Table 28: System - Wireless Channel Reference RSSI

Channel Size	Initial Setting
3.5 MHz	-75 dBm
7.0 MHz	-72 dBm

These are the suggested initial settings; adjustments to this target value must be made based on the individual RF characteristics of each deployed sector. The RSSI value (dBm) for each subscriber can be monitored using the base station SS Info screen (Web interface). Tx power adjustments are based on a number of factors, and differences of up to 7 dB may be observed between the Reference RSS setting and measured RSSI.

Auto Rx Gain Enable: Check ☑ to enable automatic adjustment of the receiver sensitivity.

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PHY Parameters

Band Select MHz: (*) Select channelization type (802.16 OFDM PHY system profiles).

Channel Size MHz: (*) Select the channel size. Menu selection is based on the type of radio installed. Refer to the appendices for a list of supported radios.

Guard Interval: (*) Select the cyclic prefix.

MAC Parameters

Frame Profile: Configure the frame size and usage profile.

Frame Duration ms: (*) Select the wireless frame duration (ms). Selections are based on the channel size. This setting affects the system latency.

DL Ratio %: Enter the downlink usage as a percentage of frame size. This setting provides traffic shaping on the uplink and downlink traffic profiles.

The DL ratio is dynamic and can be changed at any time without reboot. The DL Ratio setting in the Wireless Configuration page allows the selection between the minimum and maximum values specified in the following table (based on Frame Duration, Channel Bandwidth and Guard Interval settings):

Table 29: System - Wireless Channel Selection

Channel Size (MHz)	Frame Duration (ms)	Guard Interval	Lowest DL Ratio (%)	Highest DL Ratio (%)
3.5	5	1/16	50	75
		1/4	58	75
	10	1/16	25	80
		1/4	26	80
7	5	1/16	25	80
		1/4	30	80
	10	1/16	25	85
		1/4	25	85

Adaptive TDD: (*) This feature is provided to facilitate use of the base station for backhaul applications only and should always be unchecked (☐) during normal (PMP) operation. Refer to section 7.6: RedMAX Backhaul Application on page 123 for details.

Uplink Subchannelization: (*) (AN-100UX only) Check (☑) to enable uplink subchannelization for distant/low signal subscribers. Refer to the full description of this feature in section 7.1 Uplink Subchannelization (AN-100UX only) on page 113. Uplink subchannelization is enabled by default.

Synchronization Mode: (*) Select the synchronization mode. Refer to the RedMAX base station Installation Guidelines for details of the synchronization feature.

No Synch: Synchronization feature is disabled.

Master: This base station provides the master synchronization pulse for each connected slave base station (without external GPS clock source).

Master with GPS Synchro: This base station is connected to a GPS clock and provides the master synchronization pulse for each connected slave base station.

Backup Master: This base station normally operates as a slave. If the master base station fails to provide synchronization pulses, this unit will automatically become a Master. This feature operates with or without an external GPS clock connection.

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Slave: This base station synchronizes its operations to the synchronization pulse received from the Master or Backup Master.

Cell Range km: (*) Enter the distance to the subscriber located the farthest distance from the base station.

Disable RF: Click Disable RF to disable the modem output. This is for test purposes only. The base station must be rebooted to restore operation of the radio transmitter.

Save: Click Save to save and apply the current settings. Settings not marked with a red asterisk are effective immediately. Settings marked with a red asterisk (*) only become only effective after rebooting the base station.

Cancel: Click Cancel to restore all fields to the last saved values.

Default: Click Default to change all fields to the factory values.

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4.4.2 Ethernet Interface

Click **Ethernet Interface** in the system menu (left side of screen) to view and configure the front panel Data and Management (Mgmt) Ethernet ports, and the Intra-Sector Layer-2 Forwarding (iSL2F) feature.

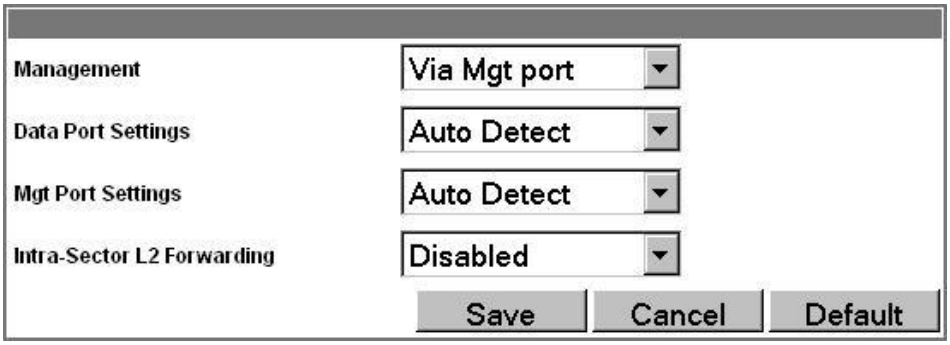

Figure 30: Web: Configuration - Ethernet Interface Screen

Management: Choose the front panel Ethernet port for management traffic.

Via Data port: The Data Ethernet port is used for data and local management traffic. The Mgt port is disabled.

Via Management port: Only the Mgt Ethernet port is monitored for local management traffic (data and management networks are physically isolated).

Data Port Settings: This setting controls the speed of the Ethernet Data port.

Auto Detect: Auto-negotiate the speed and duplex.

10 Mbps Half Duplex: Operate at 10Base-T half duplex mode only.

10 Mbps Full Duplex: Operate at 10Base-T full duplex mode only.

100 Mbps Half Duplex: Operate at 100Base-T half duplex mode only.

100 Mbps Full Duplex: Operate at 100Base-T full duplex mode only.

Management Port Settings: Set the speed of the Ethernet Management port.

Auto Detect: Auto-negotiate the speed and duplex.

10 Mbps Half Duplex: Operate at 10Base-T half duplex mode only.

10 Mbps Full Duplex: Operate at 10Base-T full duplex mode only.

100 Mbps Half Duplex: Operate at 100Base-T half duplex mode only.

100 Mbps Full Duplex: Operate at 100Base-T full duplex mode only.

Intra-Sector L2 Forwarding: This feature supports layer 2 network connectivity between subscribers in a single sector (hair-pinning).

***Important**: Refer to section 7.2.4: Intra-Sector L2 Forwarding on page 114 for more information about configuring and using iSL2F feature.*

Disabled Mode: When the Intra-Sector L2 Forwarding feature is disabled, the base station will not forward traffic between subscribers (hairpinning) and will not accept traffic resubmitted to the Ethernet port by an external switch.

External Mode: When external mode selected, the base station accepts traffic resubmitted to the Ethernet port. This permits an external switch to forward traffic between hosts located behind subscribers in the same sector.

Internal Mode: When internal mode is enabled, the base station classifies and forwards traffic between hosts located behind subscribers in the same sector (hairpinning) without requiring an external switch. Subscriber traffic arriving at the

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base station appears on the Ethernet port and is also resubmitted to the MAC for reclassification and broadcast over the air.

Save: Click Save to apply and permanently save the displayed settings.

Cancel: Click Cancel to restore displayed settings to the last saved values.

Default: Click Default to change all displayed settings to the factory default values.

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4.4.3 Management Interface

Click **Management Interface** in the system menu (left side of screen) to view and edit the IP address and DHCP settings.

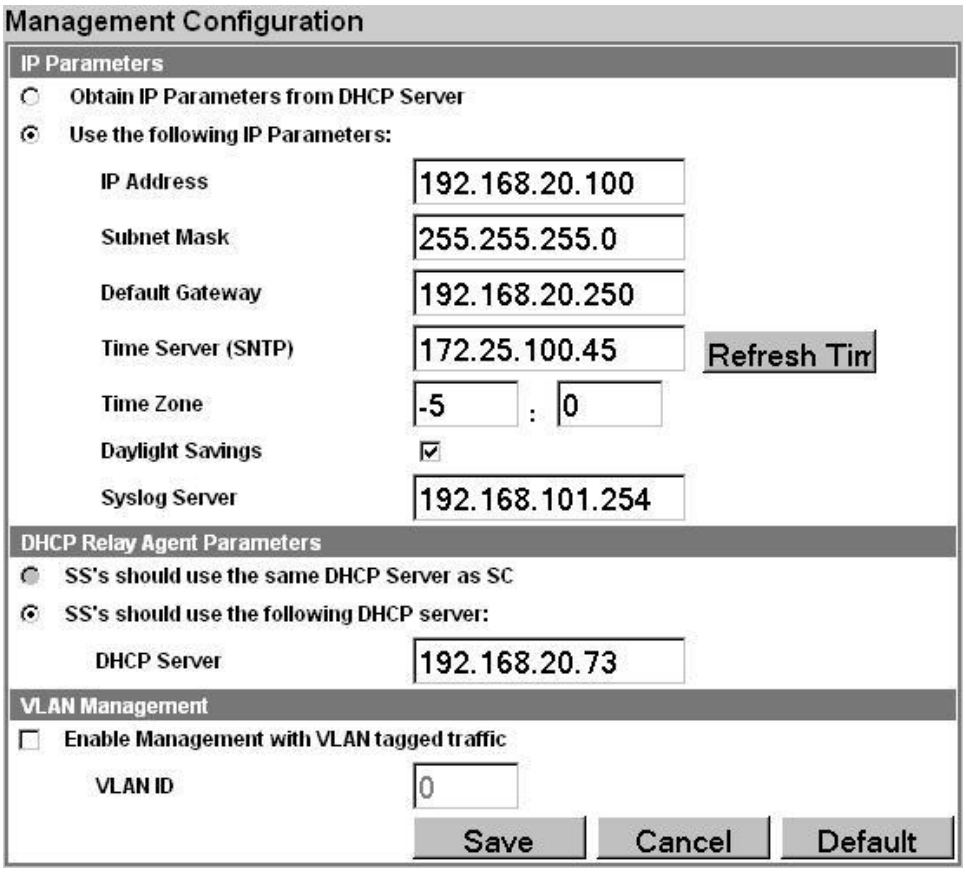

Figure 31: Web: Configuration - Management Interface Screen

IP Parameters

Obtain IP Parameters from DHCP Server: Select this option to have the base station obtain its IP address from a DHCP server.

Use the following IP Parameters: Manually enter the following IP parameters:

IP Address: Enter the static base station network IP address.

Subnet Mask: Enter the base station subnet address mask.

Default Gateway: Enter the IP address of the default gateway on the local Ethernet segment.

Time Server (SNTP): Enter the IP address of the SNTP server.

Use the following checklist to ensure correct display options:

1. Time server must be compatible with SNTP (RFC-2030)
2. Ensure the time zone is correct for your area.
3. If you are in an area that observes daylight savings time, check the box.

Time Zone: Enter the time offset from GMT (hours:minutes).

Daylight Savings: Check ☑ to enable automatic time change for daylight savings.

Syslog Server: Enter the IP address of the Syslog server to enable this feature.

Refresh: Click Refresh Time to poll the time server for the current time.

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DHCP Relay Agent Parameters

The subscriber can obtain an IP address from the DHCP server only through a base station acting as a DHCP Relay Agent. A subscriber can not obtain an IP address from any DHCP server on the network segment connected to its local Ethernet port. The base station (acting as a DHCP Relay Agent) can be configured for two different modes:

SS-s should use the same DHCP Server as SC: Select this option to have the base station forward all subscriber DHCP requests to the DHCP server that the base station used to obtain its IP address (valid only if field Obtain IP Parameters from DHCP Server is enabled above).

SS-s should use the following DHCP Server: Select this option to specify the DHCP server to be used by subscribers.

DHCP Server: Specify the IP address of a DHCP server. The base station forwards all subscriber DHCP requests to this address.

It important to configure the correct lease options on your DHCP Server:

a) The subscriber requires option 4, the address of a ToD Server (RFC-868).

b) If you do not wish your devices to display GMT, you must add option 2 (Time Offset). This is a value denoting the number of seconds to offset your time from GMT. For example, for the offset of +2 hours you should enter 7200 (some DHCP servers may require entering hexadecimal value). In North America, EST is -5 hours (-18000 seconds) from GMT and the negative value must be entered.

***Important**: The base station must be rebooted to activate changes to the DHCP Relay Agent settings.*

VLAN Management

Enable Management with VLAN Tagged Traffic: Check ☑ to manage the AN-100U/UX using VLAN tagged traffic. This feature can be used where a single management VLAN is used to manage the base station wireless equipment and user equipment. After enabling this feature, only traffic with the specified VID is recognized for any management commands. This setting does not affect operation of the RS-232 Console port.

***Important*: Network support for VLAN should be verified before enabling this feature. If the base station is not reachable using the VLAN tagged traffic, the Console port (RS-232) CLI command must be used to disable this setting.**

VLAN ID: Enter the VID of the VLAN to be used for management traffic. When Management with Tagged Traffic is enabled, only traffic tagged with this VLAN ID is recognized by the sector controller management process.

Save: Click [Save] to save and apply the current settings.

Cancel: Click [Cancel] to discard all changes and return to the main screen.

Default: Click [Default] to set all settings to the factory default settings.

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4.5 Admin Tools

The following screens are used to configure the network settings, passwords, and to download software updates to the base station.

4.5.1 Advanced Config

Click Advanced Config in the menu (left side of screen) to view and modify MAC settings for modulation thresholds, and backoff settings. Changes to settings marked with a red asterisk (*) are only effective after clicking Save and rebooting the base station. This screen has a separate user name and password. You must login as 'debug' user to access the Advanced Configuration screen. Refer to 8.3: Factory Default Settings on page 126.

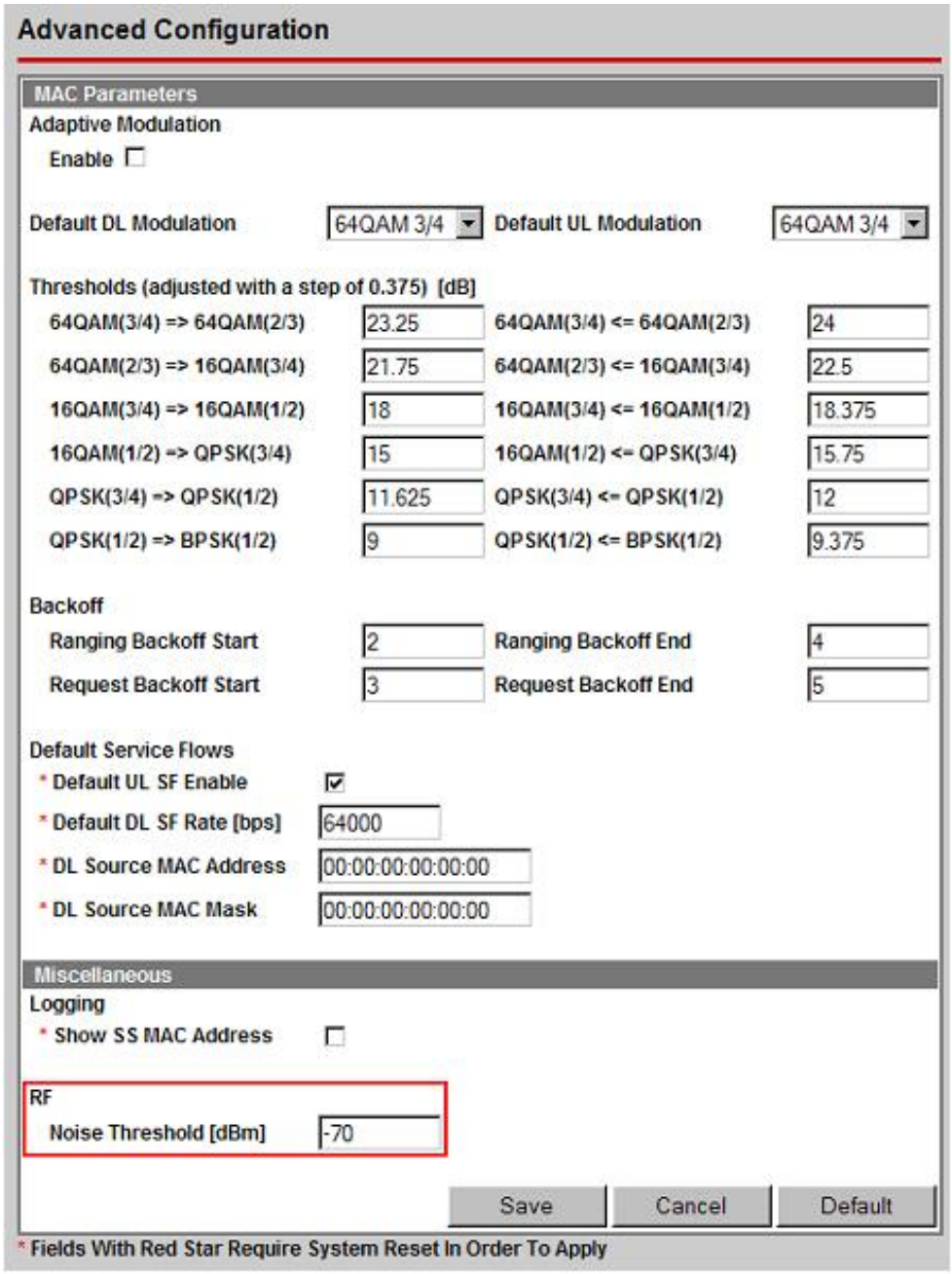

Figure 32: Web: Admin Tools - Advanced Configuration Screen

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Enable: Check ☑ to enable adaptive modulation. Enabling this control disables the default modulation settings.

Default DL Modulation: Select the default modulation and coding rate for the downlink channel. This value is used only when Adaptive Modulation is disabled. When Adaptive Modulation is disabled the base station will transmit data only using the selected modulation/coding.

Default UL Modulation: Select the default modulation and coding rate for the uplink channel. This value is used only when Adaptive Modulation is disabled. When Adaptive Modulation is disabled the base station will receive data from subscribers only using the selected modulation/coding.

Thresholds:

Enter the adaptive modulation threshold values (dB) for each modulation (based on measured CINR). The values are used only when Adaptive modulation is enabled. There are two entry fields for each threshold setting (row):

- Minimum Entry Threshold (right column)
- Mandatory Exit Threshold (left column)

The modulation/coding is decreased by one step under the following conditions:

1. CINR drops below the exit threshold of the current CINR
2. CINR is between the entry threshold and exit threshold of the current UIUC and CRC errors are detected in the uplink channel

Settings must be adjusted to match the characteristics of each deployment. Refer to the following table for recommended threshold settings. These are applicable for independent sector operation. Co-channel sector deployment in a cell may require further optimization of the Adaptive Modulation settings.

Table 30: System - Wireless - Adaptive Modulation Threshold Settings

Threshold Setting	CINR		Threshold Setting	CINR
64 QAM 3/4 => 64 QAM 2/3	23.25 dB		64 QAM 3/4 <= 64 QAM 2/3	24 dB
64 QAM 2/3 => 16 QAM 3/4	21.75 dB		64 QAM 2/3 <= 16 QAM 3/4	22.5 dB
16 QAM 3/4 => 16 QAM 1/2	18 dB		16 QAM 3/4 <= 16 QAM 1/2	18.375 dB
16QAM 1/2 => QPSK 3/4	15 dB		16 QAM 1/2 <= QPSK 3/4	15.75 dB
QPSK 3/4 => QPSK 1/2	11.625 dB		QPSK 3/4 <= QPSK 1/2	12 dB
QPSK 1/2 => BPSK 1/2	9 dB		QPSK 1/2 <= BPSK 1/2	9.375 dB

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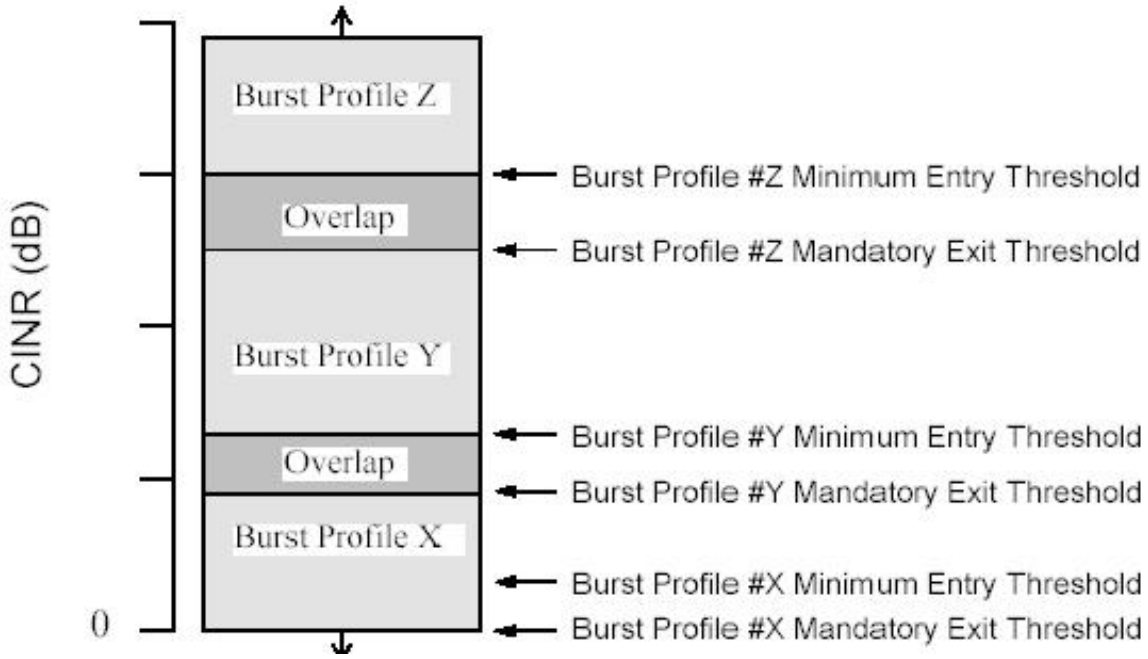

Figure 33: Web: Admin Tools - Advanced Config - Burst Profile Settings

Backoff

Specify ranging and contention periods.

Backoff settings are used when subscribers experience collisions during link establishment and requesting additional bandwidth. When a subscriber detects a collision, the following strategy is implemented to avoid further collisions.

For example, the behavior would be as follows when using the default settings (Ranging Backoff Start = 2, Ranging Backoff end = 4).

Following a collision, the subscriber will skip between zero and four registration opportunities ($2^{Ranging\ Backoff\ Start}$). If the subscriber detects a collision during the retry, it will skip a random number, between zero and eight registration opportunities ($2^{Ranging\ Backoff\ Start+1}$). If a third collision is experienced, the subscriber will skip between zero and sixteen registration opportunities ($2^{Ranging\ Backoff\ End}$). If a fourth collision is detected, the process repeats as for the first detected collision.

It is recommended to use the default Backoff values, as changes to these settings can severely impact performance of the wireless link. Click **Default** in the Advanced Config menu to restore the factory backoff settings.

Ranging Backoff Start: Enter the starting backoff window size for initial ranging contention.

Ranging Backoff End: Enter the final backoff window size for initial ranging contention.

Request Backoff Start: Enter the starting backoff window size for contention during bandwidth requests.

Request Backoff End: Enter the final backoff window size for contention during bandwidth requests.

Default Service Flows

Use the following fields to configure operation of the default uplink and downlink service flows. Learning is enabled for default service flows.

Default UL SF Enable: Check this box (☑) to enable the default UL service flow.

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Default DL SF Rate (bps): Enter the maximum rate for the default DL service flow.

DL Source MAC Address: Enter the MAC address of the aggregator. Only traffic received from the specified aggregator is forwarded to subcribers.

DL Source MAC Mask: Enter the mask value (hex) use with DL Source MAC Address.

1. A mask value of all ones (ff:ff:ff:ff:ff:ff) will match only the MAC address entered in the DL Source MAC Address field.

2. A partially specified mask value will match a range of MAC addresses. For example, a mask value of 01:02:03:ff:ff:ff will match all MAC addresses where the first 48 bits are 01:02:03. The should be set to all zeros.

3. A mask of all zeros (00:00:00:00:00:00) will match all destination MAC addresses (DL Source MAC Address field is ignored).

Miscellaneous

Show SS MAC Address Check this box (☑) to display the subscriber MAC address on the SF Info screen and in log messages. When this selection is not active, the subscriber name is displayed on the SF Info screen and in log messages.

Noise Threshold: Enter the maximum noise threshold (-104 dBm to -65 dBm).
If the measured noise (or interference) level exceeds this threshold, the base station stops transmitting until the noise level is lower than this threshold. Refer to 1.4: Deployment in the USA -- FCC Notices on page 15.

Controls

Save: Click [Save] to apply and save the displayed settings. Changes to settings marked with a red asterisk (*) are effective only after the base station is rebooted.

Cancel: Click [Cancel] to discard all changes and return to the main screen.

Default: Click [Default] to set all settings to the factory default settings.

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4.5.2 Software Upgrade

Click **Software Upgrade** in the menu (left side of screen) to upload a new system software image from a remote server. The terminal contains two non-volatile RAM banks for storing the software. Each upload overwrites the standby (unselected) bank.

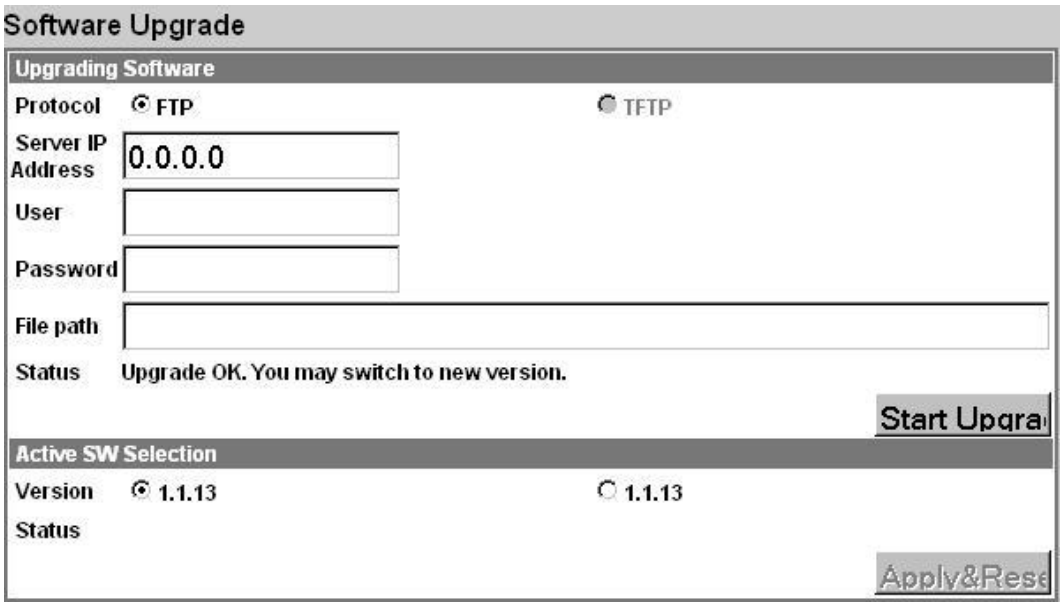

Figure 34: Web: Admin Tools - Software Upgrade Screen

Upgrading Software

Protocol: Select the type of server:

FTP: Use File Transfer Protocol for file upload.

TFTP: Use Trivial File Transfer Protocol for file upload. *TFTP is not available in the current software version.*

Server IP Address: Enter the FTP server network address.

User: Enter the username of a user that is defined on the FTP server and has sufficient access rights to the base station software image file.

Password: Enter the password for the username entered in the User field above.

File Path: Enter the path and name of the system software image to upload. It is strongly recommended to copy the binary files to the default file directory for the FTP server and to specify only the file name in this field.

Status: Monitors the software upload operation.

Start Upgrade: Click Start Upgrade to begin the software upload.

Active SW Selection

Version: Select the software image to load on the next system reboot.

Status: Monitors the system upgrade operation.

Apply&Reset: Click Apply&Reset to save the current version selection and reboot the base station.

Before Beginning the Upgrade

Use the following procedures to upgrade the base station.

The following items must be addressed before beginning the upgrade:

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1. You must obtain the latest base station binary files. You must copy the binary files into the default file location for the FTP server. You can not specify a 'path' in the upgrade dialog.
2. The base station performs all software upgrades using an FTP server:
   a) The FTP server must be located on the network connected to an active Ethernet port (Data or Mgmt) on the base station.
   b) The FTP server must have a user defined as follows:
      username: target
      password: secret

Upgrade Base Station

1. Start a Web browser session to the base station and login. The factory default settings are as follows:
   Login: admin
   Password: admin
2. Click **Software Upgrade** in the left-hand menu and make the following settings:
   Protocol: FTP
   Server IP address: [enter address of FTP server]
   User: target
   Password: secret
   File Path: [Enter binary file name -- including .bin extension]
3. Click Upgrade and wait for the base station to download and save the binary file. This process may take a few minutes. Progress is indicated in the **Status** field. The Status Screen displays '**Update OK**' when the upgrade is complete.
4. In the Software Upgrade screen, Select the new version and click Apply&Reset to activate the new software. Click Yes in the confirmation dialog.

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4.5.3 Backup and Restore

Click **Backup and Restore** in the menu (left side of screen) to manage the base station saved settings. The configuration settings for the active and alternate software loads can be saved to a network server reachable by the base station. Configuration files saved on a remote server can be used to restore settings on a base station.

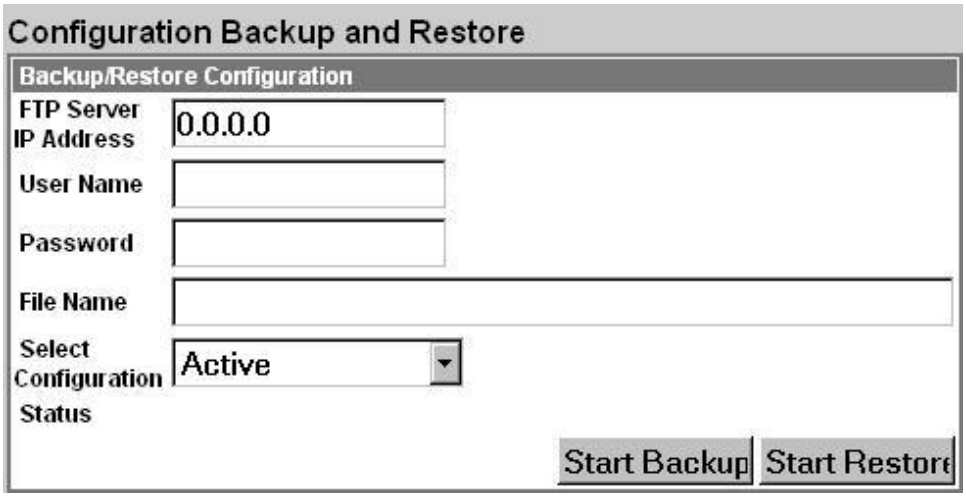

Figure 35: Web: Admin Tools - Configuration Backup and Restore Screen

Backup and Restore Configuration

FTP Server IP Address: Enter the FTP server network address.

User Name: Enter the username of an account on the FTP server. This user must have access rights to read and write files on the server.

Password: Enter the password for the user account.

File Name: Enter the path and file name of the configuration file to save or read.

When performing a backup, it is strongly recommended to use the default file directory for the FTP server and enter only the file name in this field. It is also recommended to specify a file name that includes the date and software revision.

Select Configuration:

Active: Save/restore the saved configuration for the active software load.

Alternate: Save/restore the saved configuration for the inactive software load.

Status: Displays status messages for the current operation.

Start Backup: Click Start Backup to save the selected settings (Active/Alternate).

Start Restore: Click Start Restore to restore the selected settings (Active/Alternate).

Before Beginning a Backup

The following items must be addressed before beginning the backup:

1. The settings to be saved on a remote server must be saved in the memory bank associated with the software binary file. To be sure that all current settings are saved, click **Manage** in the menu (left side of screen) and click Save to save all changes (if this control is active).
2. The base station performs all software upgrades using an FTP server. The FTP server must be located on the network connected to an active Ethernet port (Data or Mgmt) on the base station and must have a user account with read/write privileges.

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Backup Base Station Settings

Use the following steps to backup the base station settings:

1. Start a Web browser session to the base station and login. The factory default settings are as follows:

   Login: admin

   Password: admin

2. Click **Backup and Restore** in the menu and make the following settings:

   User Name: Enter the username of a user that is defined on the FTP server and has sufficient access rights to the read and write files.

   Password: Enter the password for the user account.

   File Name: Enter the path and name of the file to save.

   When performing a backup, it is strongly recommended to use the default file directory for the FTP server and enter only the file name in this field. It is also recommended to specify a file name that includes the date and software revision.

   Select Configuration: Select **Active** or **Alternate**.

3. Click Start Backup and wait for the base station to transfer the configuration file. This process may take a few minutes and progress is indicated in the **Status** field.

Restore Base Station Settings

Use the following steps to restore the base station settings:

1. Start a Web browser session to the base station and login. The factory default settings are as follows:

   Login: admin

   Password: admin

2. Click **Backup and Restore** in the menu and make the following settings:

   User Name: Enter the username of a user that is defined on the FTP server and has sufficient access rights to the read and write files.

   Password: Enter the password for the user account.

   File Name: Enter the path and name of the file to be restored.

   Select Configuration: Select **Active** or **Alternate**.

3. Click Start Restore and wait for the base station to transfer the configuration file. This process may take a few minutes and progress is indicated in the **Status** field.

4. If the restore operation was successful, and the destination was the Active memory bank, the base station is automatically rebooted. When the base station is rebooted, all traffic stops for about 30 seconds and then resumes as the subscribers are registered.

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4.5.4 SNMP Access Control List

Click **SNMP Access Control List** in the menu (left side of screen) to manage access control for SNMP managers. Use the new SNMP Access Control List screen to enable access for SNMP managers. SNMP managers are identified by IP address, port, and community read and write names (strings) and can be individually added and removed from the list.

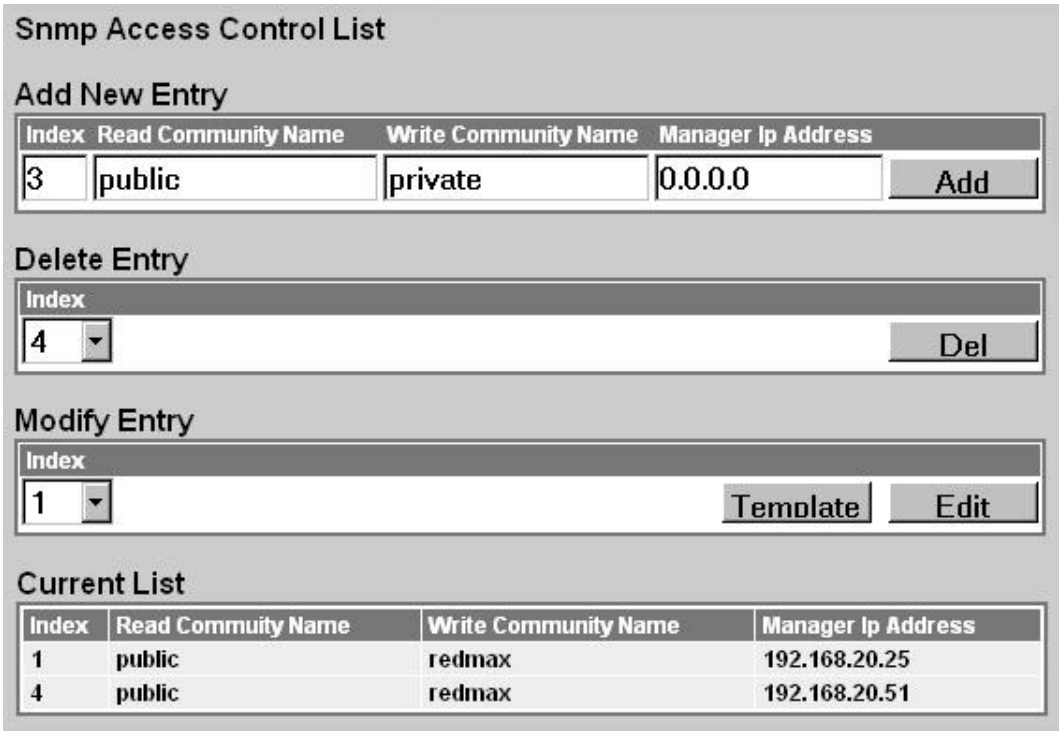

Figure 36: Web: Admin Tools - SNMP Access Control List Screen

Add New Entry

Index: Unique index number to identify this table entry. This number is generated automatically by the base station. The user can also specify an index number (must be unique) when creating a new table entry.

Read Community Name: The SNMP community name with read access.

Write Community Name: The SNMP community name with write access.

Manager Address: The IP address of the SNMP manager.

Add: Click Add to create a new table entry using the displayed parameters.

Delete Entry

Index: Select the index number for the table entry to be deleted.

Delete: Click Delete to remove the selected table entry.

Modify Entry

Index: Select the index number for the table entry to be modified.

Template: Click Template to use the current selection as a default template when creating a new table entry.

Edit: Click Edit to modify the table entry selected by the Index field. The table information is presented in the Add New Entry fields, and the Add button is changed to a Modify button.

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Current List

Index: Unique index number to identify this table entry.

Read Community Name: The SNMP community name with read access.

Write Community Name: The SNMP community name with write access.

Manager Address: The IP address of the SNMP manager.

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4.5.5 SNMP Trap Receiver List

Click **SNMP Trap Receiver List** in the menu (left side of screen) to view and change the SNMP trap message settings. Use the SNMP Trap Receiver List screen to enable sending SNMP trap messages to specified SNMP managers. Trap receivers are identified by IP address and port ID.

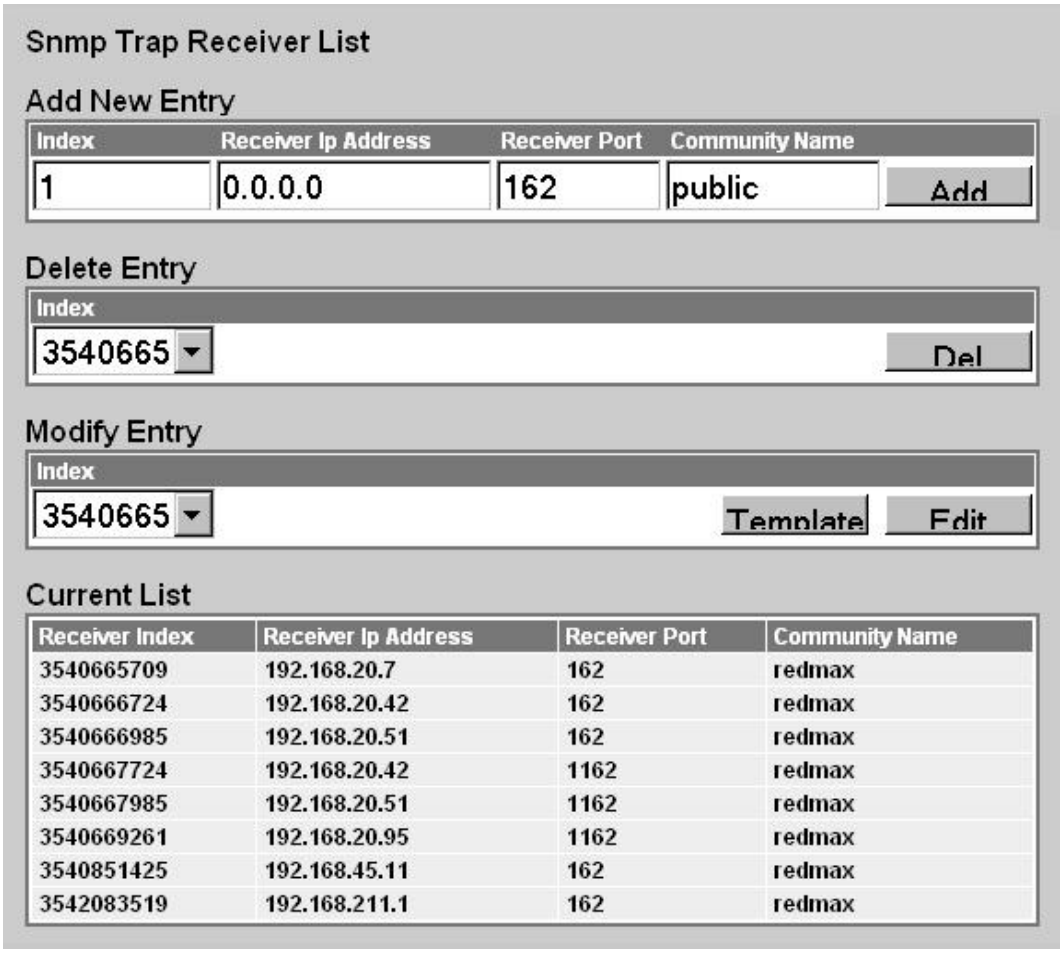

Figure 37: Web: Admin Tools - SNMP Trap Receiver List Screen

Add New Entry

Index: Unique index number to identify this table entry. This number is generated automatically by the base station. The user can also specify an index number (must be unique) when creating a new table entry.

Receiver Ip Address: The destination IP address for trap alarm messages.

Receiver Port: The destination port ID for the trap alarm messages.

Community Name: The SNMP community string name of the SNMP manager.

Add: Click Add to create the new table entry using the displayed parameters.

Delete Entry

Index: Select the index number for the table entry to be deleted.

Del: Click Del to remove the selected table entry.

Modify Entry

Index: Select the index number for the table entry to be modified.

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Template: Click [Template] to use the current selection as a default template when creating new table entries.

Edit: Click [Edit] to modify the table entry selected by the Index field. The table information is presented in the Add New Entry fields, and the [Add] button is changed to a [Modify] button.

Current List

Index: Unique index number to identify this table entry.

Receiver Ip Address: The destination IP address for trap alarm messages.

Receiver Port: The destination port ID for the trap alarm messages.

Community Name: The SNMP community string name of the SNMP manager.

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4.5.6 System Account Management

Click **Accounts Management** in the menu (left side of screen) to manage up to 30 (max.) user accounts.

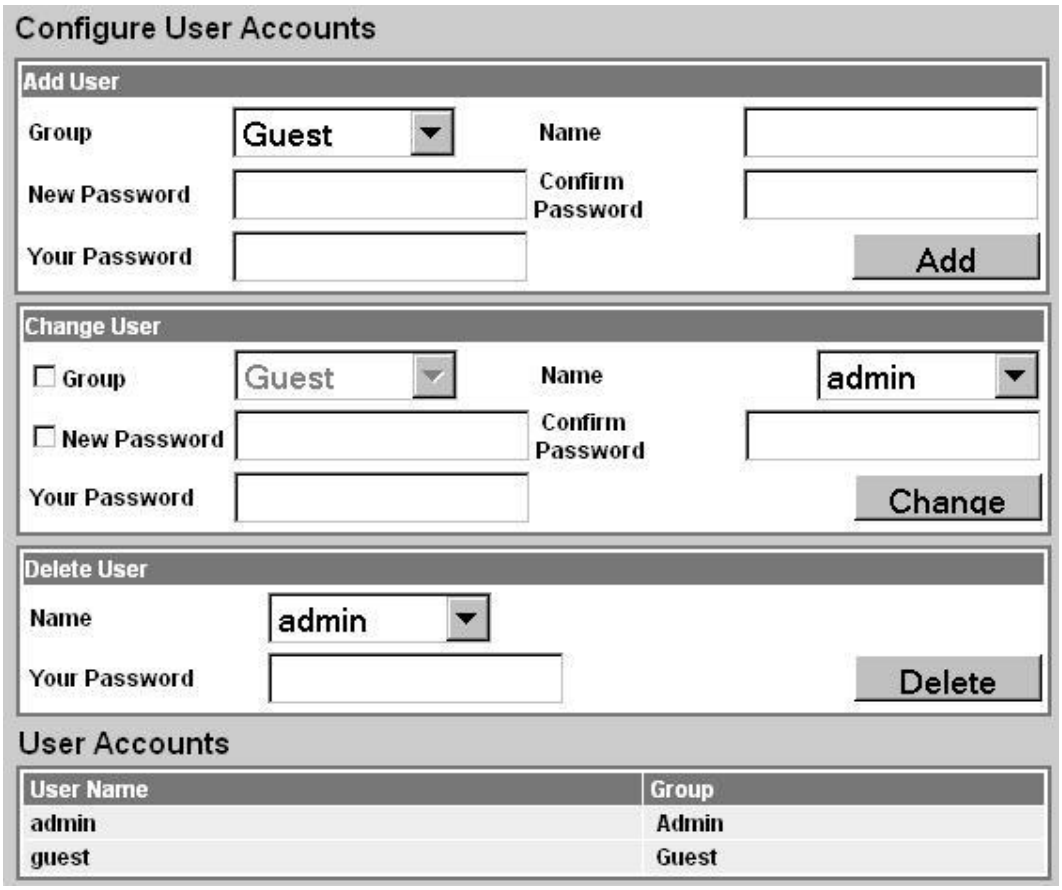

Figure 38: Web: Admin Tools - System Password Screen

Add User

Group: Select the group for this account.

Admin: This account user is an administrator.

Guest: This account user is a guest.

Name: Enter the name for this account.

New Password: Enter a new password.

Confirm Password: Re-enter the new password.

Your Password: Enter your login password.

Add: Click Add to create a new account using these settings.

Change User

Group: To change the group for this account, check ☑ and select a new group.

Admin: This account user is an administrator.

Guest: This account user is a guest.

Name: Select the name of an existing account to change.

New Password: To change the password for this account, check ☑ and enter a new password for this account.

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Confirm Password: If changing the password, re-enter the new password in this field.

Your Password: Enter your login password.

Change: Click Change to create a new account using these settings.

Delete User

Name: Select the name of an existing account to be deleted.

Your Password: Enter your login password.

Delete: Click Delete to create a new account using these settings.

User Accounts

Old Password: Enter the current password.

New Password: Enter a new password.

Confirm Password: Re-enter the new password.

Your Password: Enter your login password.

Change: Click Change to save and apply changes.

Notes:

1. To delete an administrator account, you must login using another administrator account. To delete an administrator account: a) change the account to be deleted to type 'guest', b) delete the account.
2. SNMP can be used to change the username and/or password of user accounts on the base station. This feature allows all sectors in a network to be reconfigured from a central location (e.g., Redline RMS).

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5

5 CLI Interface

The base station can be configured and monitored using the command line interface (CLI) commands. This section describes the procedures for configuring and operating the base station using the CLI over a Telnet connection.

5.1 Connecting via Telnet

To connect to the base station, open a Telnet session to the IP address of the base station (default address is 192.168.101.3).

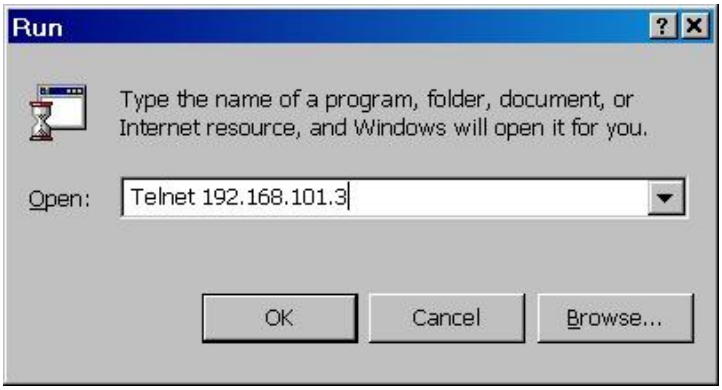

Figure 39: CLI - Connecting via Telnet

When the command prompt screen appears, login using the following (factory default) :

Username: admin

Password: admin

The base station may now be controlled using a set of CLI commands.

Telnet Logout

Exit from a CLI session by typing:

logout ENTER

The system will logout users automatically if no commands are received (idle) for five minutes.

5.2 CLI Commands

The system defaults to root mode when you login to the base station. The following table lists all base station specific commands available in root mode. All commands are case-sensitive.

The following table lists commands available in the root directory. These commands are described in detail in the following sections.

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Table 31: CLI - Command Summary	
Command	Description
debug*	Intermediate node for debugging commands
diagStatistics*	Access the Diagnostic Status data structure
interfaces	View and configure the data and management Ethernet ports
ipAddress	View and configure the IP address data structure
logout	Exit from Command Line Interface
monitor	Enter monitor mode (press any key to exit monitor mode)
reboot	Reboot the device box.
remoteFSInit*	Initialize remote File System
resetSS*	Reboot the base station
set	Command mode to view and configure system settings
show	Command mode to view system settings
softwareConfig	Backup/restore base station settings to/from FTP server
softwareUpgrade	Download software and select the active version
user	View and configure user accounts
vxShell*	Switch to VxWorks target shell
wmanIfBs	View and configure wireless MAN interface objects
wmget*	Set WindMark, with instance/argument support
wmlist*	Set WindMark, with instance/argument support
wmnext*	Set WindMark, with instance/argument support
wmset*	Set WindMark, with instance/argument support
x509	WMAN-IF-MIB X509 certificate data

*Debug user only.

5.2.1 Common Controls

Use the following CLI control commands in all configuration modes.

Table 32: CLI - Root Mode Commands	
Command	Description
?	Use the '?' character to display help for any command or mode. Example: From the root directory, enter the following command to list all parameters that can be changed using the 'set' command: set ?
CTRL-Z	Return to root mode. Cancel command entry (alternative to backspace delete).
exit	Return to parent node / mode.
	all (exit all) Return to parent mode.
logout	Terminate this telnet session. May be entered from any mode.

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5.2.2 debug

The ***debug*** command is used to view diagnostic information for the base station.

Table 33: CLI - Interface Command

Command	Parameter/Description
debug	**cableCompensation** Perform IF Cable Compensation (only when the Air Interface is Off). **dump** Save the information to the specified FTP server. <Server> - IP Address of the Server to dump data to <File> - File Name of the dump data **mode** Show/change the current debug mode setting. level - <normal(0) | monitoring(1) | debug(2)> server - IP address of the default FTP server for automatic dump of debug info and system error messages. **privacy** Change or display privacy-related settings. show - Display currently manually selected crypto suite. use56DESNoAuthDES128 - allows only crypto suite 0x010001 use56DESNoAuthRSA102 - allows only crypto suite 0x010002 useAllCryptoSuites - allows all supported crypto suites useNoEncrNoAuthDES12 - allows only crypto suite 0x000001 useNoEncrNoAuthRSA10 - useNoEncrNoAuthRSA1024 **programIfPll94MHz** Reprograms the 94 MHz PLL (only when the Air Interface is Off). **programIfRef200MHz** Reprograms the 200 MHz PLL (only when the Air Interface is Off). **programRF** Reprogram the RF PLLs (only when the Air Interface is Off). **reset** Reset the DEBUG data structure content. *CrcErrors - absolute* *SymErrors - absolute* *DlSdus - absolute* *UlSdus - absolute* *DlMpdus - absolute* *UlMpdus - absolute* *DlSecMgm - absolute* *UlSecMgm - absolute* *DlDefaultSdus - absolute* *UlDefaultSdus - absolute* *Fpc - absolute* *Bwr - absolute* *Pgb - absolute* **rxmode** Set to continuous receive mode. **set16QamPreamble** radio conformance test only **set64QamPreamble** radio conformance test only **setBpskPreamble** radio conformance test only **setQpskPreamble** radio conformance test only **setRCTmode** radio conformance test only **show** Display DEBUG data structure content. *FrameNumber - RO -- MAC statistics;* *Stations - RO -- MAC statistics;* *UlServiceFlows - RO -- MAC statistics;* *DlServiceFlows - RO -- MAC statistics;* *DlUsage - RO -- MAC statistics;* *UlUsage - RO -- MAC statistics;* *CrcErrors - Resetable -- MAC statistics;* *SymErrors - Resetable -- MAC statistics;* *DlSdus - Resetable -- MAC statistics;* *UlSdus - Resetable -- MAC statistics;*

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Table 33: CLI - Interface Command	
Command	Parameter/Description
	DlMpdus - Resetable -- MAC statistics; *UlMpdus - Resetable -- MAC statistics;* *DlSecMgm - Resetable -- MAC statistics;* *UlSecMgm - Resetable -- MAC statistics;* *DlDefaultSdus - Resetable -- MAC statistics;* *UlDefaultSdus - Resetable -- MAC statistics;* *Fpc - Resetable -- MAC statistics;* *Bwr - Resetable -- MAC statistics;* *Pgb - Resetable -- MAC statistics;* *Cinr - RO -- PHY statistics;* *Rssi - RO -- PHY statistics;* *Fofs - RO -- PHY statistics;* *Corb - RO -- PHY statistics;* **txmode** Set to continuous transmit mode.

5.2.3 deRegisterSs

The deRegisterSs command forces the base station to deregister a subscriber.

Table 34: CLI - Interfaces Command: advancedConfig (debug mode)	
Command	Parameter/Description
deRegisterSS	<MAC_Address> Yes *Example:* *AN100U#> deRegisterSs ?* *<MAC_Address> - <0 -- 00:09:02:03:00:f6; 1 -- 00:09:02:03:03:ab> Either enter a valid* *Wireless SS MAC address or enter an index number from the help* *message to select one.* *Yes - Confirmation to proceed.* *AN100U#> deRegisterSS 0* *The Subscriber 00:09:02:03:00:f6 will be de-registered. Continue? (press 'Y' to confirm, any other key to Cancel.)* *AN100U#>*

5.2.4 interfaces

The ***interfaces*** command is used to view and configure the front panel Data and Management (Mgmt) Ethernet ports and the wireless interface. Additional commands are available in debug mode.

Table 35: CLI - Interfaces Command: advancedConfig (debug mode)	
Command	Parameter/Description
set	**AdaptModEn** Enable/disable adaptive modulation. Enabling this control disables the default modulation settings. 0 -- disable 1 -- enable **default** Reset all parameters into default values. **DLModDefault** Select the default modulation and coding rate for the downlink channel. This value is used only when Adaptive Modulation is disabled. When Adaptive Modulation is disabled the base station will transmit data only using the selected modulation/coding. 0 - BPSK(1/2)

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Table 35: CLI - Interfaces Command: advancedConfig (debug mode)	
Command	Parameter/Description
	1 - QPSK(1/2) 2 - QPSK(3/4) 3 - 16QAM(1/2) 4 - 16QAM(3/4) 5 - 64QAM(2/3) 6 - 64QAM(3/4) **GpsHoldoverStart** Time in seconds after detecting GPS signal lost before entering holdover mode. Default is 30 seconds. **GpsHoldoverEnd** Time in seconds in holdover mode before reporting GPS signal lost. Default is 15 seconds. **ShowSsMac** Choose information to show in log message. 0 - disable. Show SS name in log message. 1 -- enable. Show SS MAC address in log message. **ReqBkEnd** Enter the final backoff window size for contention during bandwidth requests. Must be in range [4-8] inclusive, and equal or greater than 'ReqBkEnd'; **ReqBkStart** Enter the starting backoff window size for contention during bandwidth requests. Must be in range [2-5] inclusive, and equal or less than 'ReqBkEnd'; **RngBkEnd** Enter the final backoff window size for initial ranging contention. Must be in range [4-8] inclusive, and equal or greater than 'RngBkEnd'; **RngBkStart** Enter the starting backoff window size for initial ranging contention. Must be in range [2-5] inclusive, and equal or less than 'RngBkEnd'; **Th16Qam3/4To64Qam2/3** - CINR Value (dB) Up to 3 decimal places. **Th16Qam3/4To16Qam1/2** - CINR Value (dB) Up to 3 decimal places. **Th16Qam1/2To16Qam3/4** - CINR Value (dB) Up to 3 decimal places. **Th16Qam1/2ToQpsk3/4** - CINR Value (dB) Up to 3 decimal places. **Th64Qam3/4To64Qam2/3** - CINR Value (dB) Up to 3 decimal places. **Th64Qam2/3To64Qam3/4** - CINR Value (dB) Up to 3 decimal places. **Th64Qam2/3To16Qam3/4** - CINR Value (dB) Up to 3 decimal places. **ThQpsk3/4To16Qam1/2** - CINR Value (dB) Up to 3 decimal places. **ThQpsk3/4ToQpsk1/2** - CINR Value (dB) Up to 3 decimal places. **ThQpsk1/2ToQpsk3/4** - CINR Value (dB) Up to 3 decimal places. **ThQpsk1/2ToBpsk1/2** - CINR Value (dB) Up to 3 decimal places. **ThBpsk1/2ToQpsk1/2** - CINR Value (dB) Up to 3 decimal places. **ULModDefault** Select the default modulation and coding rate for the uplink channel. This value is used only when Adaptive Modulation is disabled. When Adaptive Modulation is disabled the base station 0 - BPSK(1/2) 1 - QPSK(1/2) 2 - QPSK(3/4) 3 - 16QAM(1/2) 4 - 16QAM(3/4)

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Table 35: CLI - Interfaces Command: advancedConfig (debug mode)	
Command	Parameter/Description
	5 - 64QAM(2/3) 6 - 64QAM(3/4)
show	*Structure --- <<Advanced Configuration Parameters* *Range Backoff Parameters* *----------* *BkStart:.....2* *BkEnd:.....4* *Request Backoff Parameters* *----------* *BkStart:.....3* *BkEnd:.....5* *Threshold Parameters* *----------* *64QAM(3/4) => 64QAM(2/3):.....23.250 dB* *64QAM(3/4) <= 64QAM(2/3):.....24.000 dB* *64QAM(2/3) => 16QAM(3/4):.....21.750 dB* *64QAM(2/3) <= 16QAM(3/4):.....22.500 dB* *16QAM(3/4) => 16QAM(1/2):.....18.000 dB* *16QAM(3/4) <= 16QAM(1/2):.....18.375 dB* *16QAM(1/2) => QPSK(3/4):.....15.000 dB* *16QAM(1/2) <= QPSK(3/4):.....15.750 dB* *QPSK(3/4) => QPSK(1/2):.....11.625 dB* *QPSK(3/4) <= QPSK(1/2):.....12.000 dB* *QPSK(1/2) => BPSK(1/2):.....9.000 dB* *QPSK(1/2) <= BPSK(1/2):.....9.375 dB* *Others* *----------* *MacAdaptiveModulationEnable:enabled(1)* *Default DL Modulation:...16QAM(3/4)(4)* *Default UL Modulation:...16QAM(1/2)(3)*
advancedConfig (debug mode only)	**NoiseThreshold**: Enter the maximum noise threshold (-104 dBm to -65 dBm). If the measured noise (or interference) level exceeds this threshold, the base station stops transmitting until the noise level is lower than this threshold. Refer to 1.4: Deployment in the USA -- FCC Notices on page 15.

Table 36: CLI - Interfaces Command: ethernet	
Command	Parameter/Description
set	Ethernet port settings. **IntSep** Select integrated or separated management mode. 0: The Data Ethernet port is used for data and local management traffic. The Mgt Ethernet port is disabled. 1: Only the Mgt Ethernet port is monitored for local management traffic. Select this mode only when data and management networks are physically isolated. **DataDuplex** Data Ethernet port settings. 0: Auto-detect speed and duplex. 1: Operate at 10Base-T half duplex mode only. 2: Operate at 10Base-T full duplex mode only. 3: Operate at 100Base-T half duplex mode only. 4: Operate at 100Base-T full duplex mode only. **default** Restore all settings to factory default values. **MgmDuplex** Management Ethernet port settings.

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Table 36: CLI - Interfaces Command: ethernet	
Command	Parameter/Description
	0: Auto-detect speed and duplex. 1: Operate at 10Base-T half duplex mode only. 2: Operate at 10Base-T full duplex mode only. 3: Operate at 100Base-T half duplex mode only. 4: Operate at 100Base-T full duplex mode only. **Intra-SectorL2Forwar** Establish a virtual private network at layer 2 between any number of subscriber CPEs in single sector. 0: Disabled - base station will not accept traffic resubmitted to the Ethernet port 1: Internal - base station creates a service flow to provide transparent tunneling for higher-layer protocols 2: External - base station allows an external switch to forward VLAN traffic back through the (originating) base station Ethernet port and over the wireless.
show	Display the Ethernet data port configuration. *Example:* *AN100U(interfaceEther ->)#> set* *IntSep - 0 -- Via Data port; 1 -- Via Management port.* *DataDuplex - 0 -- Auto Detect; 1 -- 100Mbps/Full Duplex; 2 -- 10Mbps/Full Duplex; 3* *-- 100Mbps/Half Duplex; 4 -- 10Mbps/Half Duplex.* *MgmDuplex - 0 -- Auto Detect; 1 -- 100Mbps/Full Duplex; 2 -- 10Mbps/Full Duplex; 3* *-- 100Mbps/Half Duplex; 4 -- 10Mbps/Half Duplex.* *Intra-SectorL2Forwar - 0 -- Disabled; 1 -- Internal; 2 -- External.* *default - to reset all parameters into default values.* *Yes - Confirmation to proceed.* *AN100U(interfaceEther ->)#> show* *Structure --- <<Ethernet Interface Configuration>>* *IntSep:.....ViaManagementport(1)* *DataDuplex:.....AutoDetect(0)* *MgmDuplex:.....AutoDetect(0)* *Intra-Sector L2 Forwarding:...Disabled(0)*

Table 37: CLI - Interfaces Command: management	
Command	Parameter/Description
set	**LocalIp** Enter the static base station network IP address. **LocalMask** Enter the base station subnet address mask. **DefGateway** Enter IP address of default gateway on local Ethernet segment. **DhcpEnable** 0: Manually enter the following IP parameters 1: Have the base station obtain its IP address from a DHCP server. **ToDIP** Enter the IP address of an the SNTP server. **TimeZoneHour** Enter the offset (hours) from GMT. **TimeZoneMinute** Enter the offset minutes (fraction) from GMT. **DayLightSavings** Enable automatic time change for daylight savings. 0: Disabled 1: Enabled **SysLogIP** Enter the IP address of the System Log server. **DhcpServIPUsr** Specify the IP address of a DHCP server. The base station forwards all subscriber DHCP requests to this address. **DhcpType** Set the DHCP relay type. 0: Base station forwards all subscriber DHCP requests to the DHCP server that the base station used to obtain its IP address.

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Table 37: CLI - Interfaces Command: management	
Command	Parameter/Description
	1: Subscriber to use the specified DHCP server. Use DhcpServIPUs to specify the DHCP server to be used by subscribers. **MgmtVLAN** Enable or disable management using VLAN tagged traffic. 0: Disable tagged management. 1 Enable tagged management. **VlanId** Enter the VLAN ID (VID) for the management VLAN. **default** Restore all settings to factory default values.
show	Display the Ethernet management port configuration. *Example:* *AN100U(mgmConfig ->)#> show* *Structure --- <<Management Configuration>>* *DHCP Relay Agent Params — IP, ToD & VLAN params* *Enable:.....StaticIP(0) — LocalIP:.....192.168.20.96* *DhcpServIPUsr:.....192.168.20.52 — LocalMask:.....255.255.255.0* *Type:.....Use_DhcpServIpUsr(0) — DefGateway:.....192.168.20.250* *ToDIP:.....172.25.100.45* *TimeZoneHour:.....-4* *TimeZoneMinutes:.....0* *DayLight Saving:.....Enabled(1)* *SysLogIP:.....192.168.20.73* *Management VLAN:.....No(0)* *VLAN ID:.....0*

Table 38: CLI - Interfaces Command: wireless	
Command	Parameter/Description
set	**ChannelBandwidth*** 5 -- 7 Mhz 6 -- 3.5 Mhz; **CyclicPrefix*** (phyCp) 0 -- 1/32 1 -- 1/16 2 -- 1/8 3 -- 1/4 **Default** restore all settings to factory default values. **DefaultUlSfEnable*** 0 -- disable default uplink service flows 1 -- enable default uplink service flows *Note: Default DL service flows are permanently enabled.* **MacAdaptiveTDD** 0 -- Disabled 1 -- Enable **MacAirInterfaceStatus** 0 -- disable RF 1 -- enable RF **MacDLRatio** downlink ratio (25 - 80) **MacFrmDuration** 0 -- 2.5 1 -- 4 2 -- 5 3 -- 8

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Table 38: CLI - Interfaces Command: wireless	
Command	Parameter/Description
	4 -- 10 5 -- 12.5 6 -- 20 **MacMaxDistance*** maximum distance to any subscriber **MacSubchannelization*** 0 -- Off 1 -- On default **MacSyncMode*** 0 -- NoSynch 1 -- Master with GPS Synch 2 -- Master 3 -- Slave 4 -- Backup Master **RefRSS** Enter the reference RSS value **RfAutoRxGainEnable** 0 -- disable 1 -- enable **RfDLChannel*** - <3400000 - 3600000; step=250> **RfSeparation*** - <-100000 - 100000; step=50000> **RfTxOutputPower** - <0 - 23; step=1> **SSTxPowerControl** 0 -- disable 1 -- enable **PhyClk** 80 -- UnlicensedProprietary 84 -- Multiple_Of_1.5MHz 91 -- Unlicensed 96 -- Multiple_Of_1.75MHz
show	Display the general wireless configuration. *Example:* *AN100UX(interfaces ->)#> wireless show* *Structure --- <<Wireless Configuration Parameter>>* *RF Parameters PHY Parameters* *---------- ----------* *DL Channel:.....3496500 kHz Clk:.....Multiple_Of_1.75MHz(96)* *Separation:.....100000 kHz Channel Bandwidth:.....7(5) MHz* *Tx Ouput Power:.....20 dBm Cyclic Prefix:.....1/4(3)* *Reference RSS:.....-66 dBm* *SS Tx Power Control:..enabled(1)* *AutoRxGainEnable:.....enabled(1)* *MAC Parameters Others* *---------- ----------* *MaxDistance:.....40 Km DefaultUlSfEnable:.....0* *Frame Duration:.....5(2) ms* *SynchMode:.....noSynch(0)* *Air Interface Status:..enable(1)* *DL Ratio:.....80 %* *Adaptive TDD:.....disabled(0)* *Subchannelization:....enabled(1)* *Structure --- <<RF Capability Parameters>>* *Type:.....40* *OduSerialNumber:.....3330-0101-00009*

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5.2.5 ipAddress

The ***ipAddress*** command is used to view and configure the base station IP address parameters.

Table 39: CLI - IP Address Command

Command	Parameter/Description
set	Modify the base station network IP settings. **Address**: <IP Address> Enter new IP address. XXX.XXX.XXX.XXX **Mask**: <IP Mask> Enter new Netmask value. XXX.XXX.XXX.XXX **Dhcp**: Enable or disable DHCP support. 0: - Static address 1: - DHCP allocated address. **Gateway** < Default gateway> Enter new gateway address. Requires confirmation to proceed.
show	Display all IP address information. *Structure --- <<SC IP Address Data>>* *Address:.....192.168.20.94* *Mask:.....255.255.255.0* *Dhcp:.....StaticIP(0)* *Gateway:.....192.168.20.250*

5.2.6 monitor

The ***monitor*** command is used to view a dynamically updated screen of statistics for the base station.

Table 40: CLI - Monitor Command

Command	Parameter/Description
monitor	Dynamic display of base station statistics values. For example: *MacFrameNumber: 11296* *MacDlSecMgm: 1353730* *MacStations: 5* *MacUlSecMgm: 1346805* *MacUlServiceFlows: 3* *MacDlDefaultSdus: 0* *MacDlServiceFlows: 3* *MacUlDefaultSdus: 0* *MacDlUsage: 7 %* *MacFpc: 9* *MacUlusage: 3%* *MacBwr: 1928* *MacCrcErrors: 0* *MacPgb: 0* *MacSymErrors: 0* *PhyCinr: 31.5 dB* *MacDlSdus: 3590* *PhyRssi: -12.0 dBfs* *MacUlSdus: 1889* *PhyFofs: 183 Hz* *MacDlMpdus: 3574* *PhyCorb: 0* *MacUlMpdus: 2378*

5.2.7 reboot

The ***reboot*** command is used to remotely reset the base station.

Table 41: CLI - Reboot Command

Command	Parameter/Description
reboot	Reboot the base station. Confirmation is required.

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5.2.8 set

The ***set*** command is used to control selected fields.

Table 42: CLI - Set Command	
Command	Parameter/Description
ipAddress	See the ipAddress command.
privacy	Change privacy related settings on SC. **TrustAll**: 0 -- no Privacy (authentication) is required for each subscriber where privacySS=1. 1 -- yes Privacy is disabled. **UseTestTimers**: 0 -- Use normal default timer settings 1-- Use factory test timer settings.
sysContact	Change the system administrator contact information (255 chars max). <**val**_sysLocation> Enter contact string for this device.
sysLocation	Change the system administrator contact information (255 chars max). <**val_sysLocation**>: Enter location string for this device (255 chars max.).
sysName	Change the system name (255 chars max). <**val_sysname**>: Enter the system name for this device.
variable	Define or delete a variable. If value part is absent, the variable is deleted. **NameValue** The variable name and value pair (i.e. nn=x).

5.2.9 show

The ***show*** command is used to display operating information about the base station.

Table 43: CLI - Show Command	
Command	Parameter/Description
eventLog	Display system logging events. For example: *Time:.....Tue May 23 14:17:39* *Txt:.....Radio Type 1: TB3435F7* *Time:.....Tue May 23 14:17:36* *Txt:.....RedMax AN-100U Ver. 1.0.58 started.*
ifCounters	Display counter statistics of device interfaces. For example: *Structure --- <<Interface statistics>>* *64 bits Ingress Counters 64 bits Egress Counters* *Octets:.....0* *Octets:.....0* *UcastPkts:.....1876059* *UcastPkts:.....881643* *MulticastPkts:.....0* *MulticastPkts:.....0* *BroadcastPkts:.....0* *BroadcastPkts:.....583368* *Others* *Name:.....Signal* *InDiscards:.....0* *InMulticastPkts:.....0* *InErrors:.....350* *InBroadcastPkts:.....0* *OutDiscards:.....0* *OutMulticastPkts:.....0* *OutErrors:.....0* *OutBroadcastPkts:.....583368*
ifStatus	Display status of device interfaces. For example: *Structure --- <<Interface Status>>* *Descr:..... 802.16* *Type:..... propBWAp2Mp(184* *Mtu:..... 2048*

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Table 43: CLI - Show Command	
Command	Parameter/Description
	Speed:..... 16940000 PhysAddress:.... 0:09:02:00:89: AdminStatus:..... up(1) OperStatus:..... up(1) LastChange:..... 00:00:13
interfaces	Display device interfaces. For example: Index Description MAC Address 1 802.16 00 09 02 00 89 c1 2 802.3 00 09 02 00 89 c1 3 802.3 00 09 02 00 89 c1
ipAddress	Display the IP address data. **Address**: <IP Address> - IP Address **Mask**: <IP Address> - Subnet Mask. **Dhcp**: Enable/disable DHCP support. **0**: Static address entered by user. **1**: DHCP allocated address. **Gateway**: <IP Address> - Default GatewayAddress. If no field name is specified, the whole data structure is displayed. For example: Structure --- <<SC IP Address Data>> Address:.....192.168.20.97 Mask:.....255.255.255.0 Dhcp:.....StaticIP(0) Gateway:.....192.168.20.250
learnedHosts	Display learned MAC addresses of the specified SS. <**MacAddr**> MAC address of a provisioned SS.
privacy	Display base station privacy settings. **TrustAll** - 0 -- no, 1 -- yes. **AKLifetime** - Lifetime in seconds for new AK. **TEKLifetime** - Lifetime in seconds for new TEK.
sfInfo	Display service flow info. <**MAC Address**> - Specify the subscriber MAC address **downlink** - Display downlink service flow information. **uplink** - Display uplink service flow information. For example: AN-100U(show->)#> sfInfo 00:09:02:00:8c:7f downlink << SF Information >> --- Downlink --- IfBsSfId:.....5106 ScSchedulingType:.....bestEffort(2) MaxSustainedRate:.....800000 bps ScArqEnable:.....false(2) MinReservedRate:.....0 bps SfInfoOctets:.....251088824 MaxLatency:.....0 ms SfInfoTrafficRate:.....787 Kbps TrafficPriority:.....1 SfInfoPkts:.....256244
snmpAccCtrl	Display SNMP access community strings. For example: AN-100U(show->)#> snmpAccCtrl << SNMP Access Control Table >> Read Access string: Write Access string: IP Address: public private 0.0.0.0 public 1 public 1 0.0.0.0
ssInfo	Display information about selected/all subscribers. If no MAC address is entered, information for all subscribers is returned. For example: <**MAC Address**> - Specify the subscriber MAC address << SS Information >>

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Table 43: CLI - Show Command	
Command	Parameter/Description
	MAC Address:.....00:09:02:00:a1:21 *SignalNoise:.....29.6 dB* *IpAddress:.....192.168.20.30* *SignalNoiseMax:.....31.1 dB* *BasicCid:.....47* *SignalNoiseMin:.....23.2 dB* *DownChannelModCode:.....64QAM(3/4)(6)* *CrcErr:.....0* *SsInfDownlinkRate:.....12705 Kbps* *AntennaRsl:.....-54 dBm* *UpChannelModCode:.....64QAM(3/4)(6)* *Distance:.....0 m* *SsInfUplinkRate:.....12705 Kbps*

status	Display Wireless Interface information.
	`AN100UX(show->)$> status`
	`Structure --- <<Wireless Interface Status>>`
	`Downlink Status Uplink Status`
	`Traffic:.....0 kbps Traffic:.....0 kbps`
	`BandwidthMargin:.....13824 kbps BandwidthMargin:.....3110 kbps`
	`ActiveSfs:.....0 ActiveSfs:.....0`
	`SmcRate:.....0 kbps SmcRate:.....0 kbps`
	`BwUsage:.....0 % BwUsage:.....0 %`
	`Others`
	`Cinr:.....3.0 dB`
	`RfTxPower:.....20 dBm`
	`IduTemp:.....41 Celsius`
	`OduTemp:.....33 Celsius`
	`HcsErrors:.....0`
	`CrcErrors:.....0`
	`AirInterfaceStatus:...enabled(1)`
	`ScSynchroStatus:....noSynchro(0)`
	`RegisteredSSs:.....0`
	`ReferenceRss:.....-70 dBm`
	`PowerSupplyStatus:.....AB-On(3)`
	`FansStatus:.....main(1)`
	`NarrowestSubchannel:1/2-Subch(1)`

sysContact	Display contact info of system administrator.
sysDescr	Display info about system hardware and software.
sysLocation	Display system location information.
sysName	Display system name.
sysUpTime	Display system time running since last reboot.
version	Display the running software version.

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5.2.10 snmpAccCtrl

Use the ***snmpAccCtrl*** command to enable access for SNMP managers. All SNMP managers are identified by IP address, port, and community read and write names (strings) and can be individually added and removed from the list.

Table 44: CLI - snmpAccCtrl

snmpAccCtrl <add> <alias> <delete> <edit> <show>

Configure SNMP account access settings.

add <EntryIndex> <ReadCommunity> <WriteCommunity> <ManagerIpAddress>

Create a new SNMP trap. The index value is assigned automatically. Up to eight settings may be entered.

EntryIndex: Unique index number to identify this table entry.

Read Community Name: The SNMP community name with read access.

Write Community Name: The SNMP community name with write access.

Manager Address: The IP address of the SNMP manager.

alias <alias name> <replacement text>

alias name: Text to be replaced

replacement text: Text to substitute for alias

delete <EntryIndex> [All | YesToAll]

<EntryIndex> - Entry index number.

All: Remove all the entries except the first one.

YesToAll: Confirmation to remove all entries.

edit <index> <ReadCommunity> <WriteCommunity> <ManagerIpAddress>

EntryIndex: Unique index number to identify this table entry.

Read Community Name: The SNMP community name with read access.

Write Community Name: The SNMP community name with write access.

Manager Address: The IP address of the SNMP manager.

show

```
        << SNMP Access Control Table >>
 Index: Read Access string:        Write Access string:       IP Address:
   1    public                     private                    0.0.0.0
```


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5.2.11 softwareConfig

The ***softwareConfig*** command is used to load new software binary files on the base station. See section 4.5.2: Software Upgrade on page 77.

Table 45: CLI - Software Upgrade Command	
Command	Parameter/Description
backup	Save a backup copy of the base station settings on a remote FTP server. **Server**: IP Address of the FTP server. **File**: Use this name when saving the configuration backup file. **Which**: Specify the settings to be saved: 0 - Alternate configuration. 1 - Active configuration. For example: *backup 192.168.20.100 BS_024-061108.cfg 1 <ENTER>* You will be prompted by the FTP server to enter a valid username and password.
restore	Restore the base station settings using a backup copy previously saved on a remote FTP server. **Server**: IP Address of the FTP server. **File**: Use this name when saving the configuration backup file. **Which**: Specify the settings to be saved: 0 - Alternate configuration. 1 - Active configuration. For example: *restore 192.168.20.100 BS_024-061108.cfg 1 <ENTER>* You will be prompted by the FTP server to enter a username and password.

5.2.12 softwareUpgrade

The ***softwareUpgrade*** command is used to load new software binary files on the base station. See section 4.5.2: Software Upgrade on page 77.

Table 46: CLI - Software Upgrade Command	
Command	Parameter/Description
loadimage	Download software image and write into flash. **Server**: <IP address> - Address of ftp server **File**: <filename.bin> - Enter file name (including .bin extension).
show	Display the S/W version information in the device.
switch	Switch between the active and inactive software versions. Requires user confirmation to proceed.

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5.2.13 user

The ***user*** command is used to modify the user profiles and passwords.

Table 47: CLI - User Command	
Command	Parameter/Description
access	Change user access level **name** <username> - User login name <access> - Access level (0-10)
add	Add a user **name** <username> - User login name to be added <access> - Access level (0-10)
delete	Delete a user **name** <username> - User login name to be deleted To delete an administrator account, change the account to be deleted to access level '0' (guest) and then delete the account.
password	Change user password. User is required to enter/confirm new password for this account. <**username**> - User login name
show	Show all users. For example: *User: admin Access: 10 (Administrator level)* *User: guest Access: 0 (Guest access level)*

5.2.14 wmanIfBs

The ***wmanIfBs*** command is used to …

Table 48: CLI - WmanIfBs Command	
Command	Parameter/Description
classifier	View or modify the wmanIfBsClassifierRuleTable. **add** add an instance to the wmanIfBsClassifierRuleTable **delete** remove an instance from the wmanIfBsClassifierRuleTable **show** display one or all instances in the wmanIfBsClassifierRuleTable
provForSf	View or modify the wmanIfBsSsProvisionedForSfTable. **add** add an instance to the wmanIfBsSsProvisionedForSfTable **delete** remove an instance from the wmanIfBsSsProvisionedForSfTable **show** display one/all entries in the wmanIfBsSsProvisionedForSfTable
saveAll	Save into non-volatile memory any changes to the SF configuration setting.
serviceClass	View or modify the wmanIfBsServiceClassTable. **add** add an instance to the wmanIfBsServiceClassTable **delete** remove an instance from the wmanIfBsServiceClassTable **show** display one or all instances in the wmanIfBsServiceClassTable
sf	View or modify the wmanIfBsProvisionedSfTable. **add** add an instance to the wmanIfBsProvisionedSfTable **delete** remove an instance from the wmanIfBsProvisionedSfTable **show** display one or all instances in the wmanIfBsProvisionedSfTable
ssConfig	View or modify the subscriber information. **add** Add Subscriber Station entry. **delete** Remove Subscriber Station entry(s). **edit** Modify an existing Subscriber Station entry.

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Table 48: CLI - WmanIfBs Command	
Command	Parameter/Description
	<SsProvIndex> Table index number for Subscriber Station to edit. macAddress Edit MAC address of the provisioned SS. sysName Edit administratively-assigned name for this SS. hostNum Edit maximum number of hosts reachable through SS. learningControl Enable or Disable MAC address learning: 1 -- Learning disabled, 2 --Learning enabled. **show** Display all Subscriber Station entries.

5.2.15 x509

The ***x509*** command is used to manage privacy sublayer certificates. AN FTP server is required to upload certificates. AN-100U/UX units shipped from the factory do not contain any certificates. The end-user must all required certificates. Loading certificates does not automatically enable the privacy options. Refer to section 7.3: Privacy Layer -- Encryption on page 116 for additional information.

Important: When using privacy, you must obtain and load the following two X.509 certificates (availalable from your Redline Certified Partner):

Redline_Communications_Root_CA_509.cer

Redline_Communications_Root_CA_R_509.cer

Table 49: CLI - x509 Command		
Command	Parameter/Description	
x509	**add**	Download a certificate to the AN-100U/UX.
	<Server>	IP Address of the Server where certificate is located.
	<File>	Certificate file name. (i.e. *.cer or *.pem)
	delete	Delete certificate(s) from the AN-100U/UX.
	<Index>	Specify the certificate to remove by index number in the table. Use '-1' to remove all certificates.
	show	Display certificates stored in the AN-100U/UX. This list displays the index number for each certificate.

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6

6 Traffic Scheduling

6.1 Overview

There are several challenges when transporting traffic over a WiMAX interface:

1. Some jitter and delay is necessarily introduced by the half-duplex operation of the TDD (time division multiplex) wireless interface.
2. Designating quality of service (e.g., priority, throughput, and latency) settings for specific connections affects all other traffic.
3. Additional factors include state of the wireless interface, uplink/downlink ratio, frame size, management traffic, queue sizes, distribution of bandwidth between subscribers, and special services including subchannelization.

This document describes the function of the RedMAX wireless traffic scheduling algorithm, the types of traffic being scheduled, and the effects of Quality of Service (QoS) settings.

For each connection type, the minimum rate, maximum rate, and latency are important factors used in scheduling traffic. Understanding the characteristics of each connection type and associated settings can help operators configure the system for optimum operation.

Notes:

Throughout this document, service flows are referred to as 'connections'.

In all cases except uplink UGS, unused connection bandwidth is always recovered for use by other connections or services.

6.2 Scheduling Factors

The base station schedules the transmission of all data sent over the wireless interface. This centralized scheduling eliminates contention, increases predictability, and provides the maximum opportunity for reducing overhead. The scheduling algorithm is functionally the same in the base station and subscriber, except that subscribers must request and receive uplink bandwidth grants from the base station before transmitting uplink traffic. Subscribers are not guaranteed to receive requested bandwidth.

6.2.1 Bandwidth Margin

The sector wireless bandwidth capacity is evaluated in real-time by monitoring the modulation and coding rates for all subscribers. The sector capacity is compared to the total committed bandwidth requirements (Min. Sustained Rate) for all UGS, rtPS, and nrtPS connections and the results are reported as uplink and downlink bandwidth margins. These values can be monitored using SNMP and HTTP (Wireless Status page). The margin values are updated to reflect changing conditions on the wireless link (e.g., interference) and of connections being added and deleted.

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Important: If the committed uplink and/or downlink bandwidth exceeds the sector capacity, the associated bandwidth margin is displayed as zero. A zero value for an uplink or downlink bandwidth margin indicates the scheduler may not be capable of meeting the minimum bandwidth requirements for all connections and a warning message is appended to the system log.

6.2.2 Scheduling Priority

The scheduler uses the following priority structure when allocating bandwidth for uplink and downlink connections. The references '$Conn_1$ … $Conn_n$' refers to order of creation for each connection as a specific priority level.

Table 50: Scheduling - Scheduler Priority

Priority	Type	Description
I	Wireless Management	Basic and Primary CID connections
II	CPE Management	Bandwidth reserved for secondary management channel (SMC) as required: Downlink: 256 Kbps (max.) shared with all subscribers. Uplink: 32 Kbps (max.) per subscriber.
III	UGS	UGS $Conn_1$ … UGS $Conn_n$
IV	rtPS	rtPS $Conn_1$ … rtPS $Conn_n$
V	nrtPS	nrtPS Priority 7 $Conn_1$ … nrtPS Priority 7 $Conn_n$ … nrtPS Priority 0 $Conn_1$ … nrtPS Priority 0 $Conn_n$
VI	BE	BE Priority 7 $Conn_1$ … BE Priority 7 $Conn_n$ … BE Priority 0 $Conn_1$ … BE Priority 0 $Conn_n$
VII	Subchannelization	Mandatory Subchannelization (UL only)
VIII	CPE Management*	All unassigned uplink and downlink bandwidth is assigned to SMC connections (as required).

6.2.3 Metered Throughput

The amount of data each connection transmits over the wireless interface is monitored and Max. Sustained Rate settings are enforced. The metered interval is a common one-second (clock tick) and the statistics for all connections are reset at the beginning of each interval. If the maximum throughput is reached before the end of the current interval, that connection is excluded from sending additional data until the next clock tick.

For example, if a connection transmits its full data allocation (Max. Sustained Rate) in the first 650 ms of the current metering interval, the connection will receive no additional bandwidth allocation until the next clock tick (a forced pause of 350 ms).

Important: The Max. Sustained Rate must accurately account for peak traffic rates to avoid dropped packets (queue full) or introducing excessive latency.

6.2.4 Connection Queue Size

Factors affecting the scheduler's ability to meet throughput requirements include connection priority, queue size, traffic patterns (bursts), and throughput metering.

The connection queue size (bytes) can be calculated as follows:

QueueSize = 4 * (Max. Sustained Rate (bps) * Frame Duration / 8) + 18 KB

For example, a connection with a Max. Sustained Rate of 409,600 Mbps may forward up to 51.2 KB over the wireless link during any one-second interval and hold up to 20,048 bytes in its queue.

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The Max. Sustained Rate determines the connection queue size, and controls the rate packets are forwarded over the wireless interface, but does not restrict the rate at which packets are received from the local Ethernet interface. Ethernet flow control mechanisms are not effective because the Ethernet switch has no information about how packets are assigned to individual connections.

The following table lists the queue sizes for a range of Max. Sustained Rates.

Table 51: Scheduling - Queue Sizes for 10 ms Frame Duration

Max Sustained Rate (bps)	Queue Size (Bytes)
2 508 800	30 640
1 214 400	24 072
1 024 000	23 120
409 600	20 048
204 800	19 024
102 400	18 512
51 200	18 256

There is no data aging, and the queue stores packets until they are transmitted over the wireless interface or the connection is deleted. If a connection queue reaches capacity, then newly arriving packets are immediately discarded.

Under normal conditions, many services and applications are competing for the same bandwidth, and the traffic may arrive in bursts. The service class type and service flow settings must be selected to facilitate forwarding data onto the wireless link at a rate that does not overflow the queue for that connection.

6.2.5 Uplink Subchannelization

The uplink subchannelization (USC) feature (AN-100UX only) provides opportunities to increase sector uplink throughput and establish wireless links to medium and low signal subscribers (v2.1 or higher). Refer to section 7.1: Self-Provisioning Features on page 114 for additional details.

6.2.6 Backhaul Mode

The RedMAX equipment can be configured to operate as a simple wireless bridge without QoS services. This is accomplished using a one uplink and one downlink connection both set to Best Effort (BE) and a Max. Sustained Rate of 25.4 Mbps. The uplink/downlink ratio is set to 'dynamic' and is adjusted automatically based on traffic patterns.

The Secondary Management Channel (SMC) exchanges management and configuration data over the wireless interface with subscribers that have remote management enabled. This includes all HTTP, TELNET, FTP, and SNMP exchanges. Bandwidth is assigned only when required by pending management operations. All unused bandwidth is available for other scheduling activities.

The SMC bandwidth is allocated (as required) in two passes:

Pass 1: Downlink: 256 Kbps (max.) shared between all subscribers.

Uplink: 32 Kbps (max.) per subscriber.

Pass 2: All unassigned uplink and downlink bandwidth may be assigned to SMC connections.

For example, when a software upgrade is in process for a subscriber, the downlink connection is guaranteed a minimum of 256 Kbps (320 bytes/wireless frame @ 10 ms Frame Duration). Note that a portion of this bandwidth may also be allocated to other

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ongoing manual or automated operations. Any unused bandwidth available after allocations to all active connections is also available.

Important: This bandwidth is shared for all subscribers in the sector. Initiating multiple management operations simultaneously (e.g., subscriber software upgrades) may have a severe impact on any ongoing operator sessions (HTTP/TELNET) or automated operations (SNMP, Syslog) during high traffic.

6.3 Deficit Round Robin Algorithm

The sector controller uses Deficit Round Robin (DRR) scheduling. The DDR algorithm provides a balance of efficiency and fairness for traffic sent over a wireless interface. In summary, the opportunity to transmit packets is based on a combination of the minimum reserved bandwidth, packet size, and elapsed time. DRR Scheduling has the following characteristics.

6.3.1 New Connection

When a connection is created, the DRR scheduler uses the following components for scheduling:

Deficit Counter (d): This counter is a threshold used to determine when a connection is eligible to transmit data. When transmitting data, the counter indicates the minimum amount of data to be transmitted for the qualifying connection. This counter can not be less than zero.

Quantum (Q): The quantum is a calculated value used to factor the deficit counter (d).

Q = Min. Reserved Rate * Frame Duration / 8

The connection is tagged as inactive until packets are queued to be transmitted over the wireless interface.

6.3.2 Packets in Queue

When packets are queued to be transmitted over the wireless interface, the connection is tagged active and will be included in scheduling for the next wireless frame.

When evaluating the connections eligibility to be included in a wireless frame, the deficit counter (d) is first increased by the quantum (Q). The result (d + Q) is compared to the size of the next packet in the connection queue. Bandwidth is allocated in the current wireless frame only when the deficit counter (d) is greater than the size of next queued packet.

deficit < size_next_packet:

No packets are transmitted for the current frame. The deficit counter (d) value is carried forward to scheduling for the next wireless frame. The value of the deficit counter (d) will accumulate over multiple wireless frames until it meets or exceeds the size of the next queued packet.

deficit ≥ size_next_packet:

Bandwidth up to the current value of the deficit counter (d) may be allocated in the current wireless frame. Generally, only complete packets are transmitted. The total number of bytes transmitted is subtracted from the deficit counter (d) and the difference is carried forward to the next frame.

6.3.3 No Packets in Queue

The deficit counter is not modified when an active connection has no packets queued. If no packets are queued for 16 consecutive wireless frames, the connection is tagged inactive and the deficit counter is set to zero.

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For example, the Min. Reserved Rate of 409,600 bps has a quantum (Q) of 512 bytes. If an application using this connection sends a 1500 byte packet, the packet will not be transmitted immediately, because the initial deficit counter value (Q = 512) will be less than the packet size. The deficit counter will accumulate to 1536 on the 3rd wireless frame (3 x 512 = 1536) and the packet may be transmitted (based on priority and available bandwidth). After the packet is transmitted, the updated deficit counter will be 1536 - 1500 = 36.

The following table lists some throughput rates and the associated Q size.

Min. Reserved Rate = Q * 8 / Frame Duration

Table 52: Scheduling - Sample Quantum (Q) Values (10 ms Frame)

Quantum Q (Bytes) *	Min. Sustained Rate (bps)
3 160	2 528 000
1 518	1 214 400
1 280	1 024 000
512	409 600
256	204 800
128	102 400
64	51 200

6.4 Connection Types

User traffic is transmitted only over connections (service flows). Each connection represents a unidirectional data flow between the base station and subscriber. Downlink connections control traffic from the base station to the subscriber and uplink in the opposite direction.

Each connection type has unique characteristics applicable to transporting specific types of user traffic across the wireless interface. Connections may be assigned individual Quality of Service (QoS) settings including priority, throughput rates, and maximum latency. The following sections describe each connection type and the associated scheduling requirements.

6.4.1 UGS - Unsolicited Grant Service

The UGS service has the highest priority after management traffic and has the lowest latency and jitter. This service is designed for real-time applications sending fixed size packets at a constant rate. Typical applications include VoIP without silence suppression, legacy TDM, or fixed-rate video. The UGS service reserves a fixed-size bandwidth allocation in every scheduled wireless frame.

Important: The Max. Reserved Rate should be based on a calculation that enumerates the number of packets to be included in a wireless frame. A simple estimate based only on minimum bandwidth may not provide optimum use of the reserved bandwidth (see examples following).

Downlink Connections

Max. Sustained Rate: Specify the required minimum bandwidth to reserve in every wireless frame. Allocation is based on queued packets and unused downlink bandwidth is available for use by other connections or services. Downlink UGS traffic is reserved in every wireless frame (Max. Latency setting is ignored).

For example, an application is sending 400 x 610 byte packets each second in the downlink direction. The downlink UGS service flow reserves bandwidth in every wireless frame.

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*Max. Sustained Rate = 400 x 692 * 8 + 5% = 2,325,120 bps*

*Q = (2,325,120 bps / 8) * 10 ms = 2,907 bytes*

Uplink Connections

When an uplink UGS connection becomes active, the base station schedules recurring unsolicited bandwidth grants for that subscriber. Pre-scheduled grants reduce the overhead and latency associated with normal uplink poll-request-grant sequences. The grant size is based on the UGS bandwidth requirement and the interval is based on the latency requirement.

Max. Sustained Rate: Specify the required bandwidth plus 5% (overhead).

Max. Latency: Specify the expected interval between consecutive packets.

The uplink UGS grant is calculated as follows:

Grant Interval = Max. Latency (milliseconds)

Grant Size = Max. Reserved Rate * Max. Latency

Important: The reserved bandwidth grant is issued at regular intervals, even if there are no packets queued on the subscriber for this connection. The grant interval is temporarily extended x4 if no packets are received on this connection for 16 consecutive wireless frames.

For example, an application is sending 400 x 610 byte packets each second in the uplink direction and the required Max. Latency is 50 ms.

*Max. Reserved Rate = (400 p/s x 692 bytes * 8) + 5% = 2,325,120 bps*

Grant Interval = 50 ms

*Grant size = (2,325,120 bps / 8) * 50 ms = 14,532 bytes*

The uplink UGS service flow will receive a grant of 14,532 bytes every 50 ms

6.4.2 Real-Time Polling Service (rtPS)

The rtPS service is next in priority after UGS. This service is designed for real-time applications that typically send 'bursts' of variable size packets and specify maximum packet delay (latency). Typical applications include MPEG for remote video surveillance and VoIP with silence suppression.

Min. Reserved Rate: The required Committed Information Rate (CIR). The setting affects the size of the bandwidth allocation.

Max. Sustained Rate: The required Peak Information Rate (PIR). Traffic is capped at this rate, measured per connection over a one-second interval.

Max. Latency: The maximum desired latency for this connection. This affects the size of the bandwidth allocation and the interval of data transmissions.

Inter-packet delay and jitter are typically introduced when bursts of traffic are too large to transmit in a single wireless frame. The Max Latency setting is used to adjust the scheduling characteristics for rtPS connections and control latency. When a latency value is specified, the scheduler performs traffic shaping to reduce inter-packet latency and jitter.

The modified rtPS scheduling has the following characteristics:

When a latency value is specified, a latency factor (L) is calculated.

L = RoundDown (Max. Latency / Frame Duration) - 2

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1. The latency value is used to modify the quantum (Q), to enable sending a greater amount of data in a single wireless frame. The intent is to provide opportunities to transmit related packets in the same wireless frame.

   Q = (Min. Reserved Rate * Frame Duration / 8) * (L + 1)

2. When packets have been transmitted in a wireless frame, the connection will not receive any bandwidth allocation during the next L-1 sequential wireless frames. This delay ensures the total throughput for the connection does not exceed the Max. Sustained Rate.

Generally, the scheduler should be able to send data for an rtPS connection in every wireless frame when **Max. Latency < 3 X Frame Duration**. The following tests may be applied to validate that the desired latency can be achieved:

The downlink latency requirements can be achieved only when both of the following conditions are true (where UL ratio may be from 0.15 to 0.75):

i) **Burst_Size_Bytes <= Q * (L+1)**

ii) **Max. Latency >= Min [Frame Duration * 2, Frame Duration * (%UL ratio +1.5)]**

3. Latency settings are ignored under the following condition:

   (Max. Latency < 3 * Frame Duration)

The following formulas can be used to estimate the expected latency. Use the table below to determine the time required to transmit the data.

$$\textbf{Latency}_{Min} = 2.4\ ms + (T_{FrameRate} * UL\ \%) + (PDU_{Ref} / 1000 * T_{Rate})$$

$$\textbf{Latency}_{Max} = \textbf{Latency}_{Min} + T_{FrameRate}$$

Table 53: Scheduling - Approximate Times to Transmit 1K Bytes

Modulation & Coding	Bytes/ OFDM Symbol	Time to Send 1K Bytes (ms)			
		CP=3.5 MHz CP=1/4	CP=3.5 MHz CP=1/16	CP=7 MHz CP=1/4	CP=7 MHz CP=1/16
64 QAM 3/4	108	**0.74**	**0.64**	**0.37**	**0.31**
64 QAM 2/3	96	**0.83**	**0.71**	**0.42**	**0.35**
16 QAM 3/4	72	**1.1**	**0.94**	**0.56**	**0.47**
16 QAM 1/2	48	**1.7**	**1.4**	**0.83**	**0.71**
QPSK 3/4	36	**2.2**	**1.9**	**1.1**	**0.94**
QPSK 1/2	24	**3.3**	**2.8**	**1.7**	**1.4**
BPSK 1/2	12	**6.7**	**5.7**	**3.3**	**2.8**

Example: Consider a connection with the following settings:

Min. Reserved Rate = 409,600 bps *Frame Duration = 10 ms*

Max. Latency = 65 ms

L = RoundDown (55 ms / 10 ms) - 2 = 3

*Q = (409,600 bps * 10 ms / 8) * (3 +1) = 2,048 bytes*

The scheduler assigns a quantum of 2,048 bytes (versus 512 bytes when latency is not specified). This allows up to four times the data throughput and related packets can be transmitted together in the same wireless frame. No bandwidth will be allocated to this connection for the next three consecutive wireless frames, and then the pattern repeats. The latency and bandwidth settings can be adjusted to ensure a 'best fit' for the application.

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6.4.3 Non-Real-Time Polling Service (nrtPS)

The nrtPS service is next in priority after rtPS, and is designed for applications that send variable sized packets and are not time-critical, but do require priority processing to ensure delivery. Typical applications include interactive web-based applications and high bandwidth FTP.

Min. Reserved Rate: The required Committed Information Rate (CIR). The scheduler attempts to allocate this minimum bandwidth in every wireless frame.

Max. Sustained Rate: The required Peak Information Rate (PIR). Connection traffic is capped at this rate, measured per connection over one-second intervals.

Priority: Enter the relative priority to other nrtPS connections, where zero (0) is low and seven (7) is high. Connections with the same priority are processed based on time of creation, and connections not receiving bandwidth in a wireless frame received elevated priority in subsequent passes until serviced.

6.4.4 Best Effort (BE)

The BE service is the lowest priority, and is designed for applications that send variable sized packets, are not time-critical, and do not specifically require any guarantee of delivery. Typical applications include web browsing, and low bandwidth FTP.

BE connections receive bandwidth only after allocations are made to all eligible higher priority connections. Under high traffic conditions, BE traffic may be delayed for an extended periods. Note that connection queues do not have 'data aging' and all traffic will be transmitted (unless connection is deleted).

Max. Sustained Rate: The required Peak Information Rate (PIR). Connection traffic is capped at this rate, measured per connection over one-second intervals (see Metered Throughput).

Priority: Enter the relative priority to other BE connections, where 0 is low and 7 is high. Connections with the same priority are processed based on time of creation, and connections not receiving bandwidth in a wireless frame received elevated priority in subsequent passes until serviced.

6.5 RedMAX Traffic Scheduler

6.5.1 Stage 1: Wireless Management

This stage allocates bandwidth for basic and primary CID connection activities.

6.5.2 Stage 2: CPE Management (Reserved)

This stage allocates the guaranteed minimum bandwidth (if required) for the secondary management channel (SMC) traffic, including HTTP, FTP, SNMP, and TELNET traffic.

6.5.3 Stage 3: Service Flows

This stage allocates bandwidth for connections with packets queued for transmission

Stage 3.1

Stage 3.1 assigns bandwidth to UGS, rtPS, and nrtPS connections with packets queued for transmission. Pass 1 begins with the oldest active connection having the highest priority level. For each connection, bandwidth is allocated to up to the current value of the deficit counter, or to empty that connection queue (whichever is less).

Pass 1 continues based on descending age at the same priority level, and then with the next lower priority level. Pass 1 ends when all UGS, rtPS, and nrtPS connections are processed or all available bandwidth has been allocated.

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Stage 3.2

Processing continues with stage 3.2 if additional bandwidth is available at the end of Stage 3.1. Repeating the same priority processing, Stage 3.2 begins by allocating additional bandwidth (as required) up to the Max. Sustained Rate, or to empty that connection queue (whichever is less). Stage 3.2 continues until all active connections are processed or all available bandwidth has been allocated.

Notes:

The Max. Sustained Rate is metered over one-second intervals, and this setting does not otherwise restrict the bandwidth allocated to a connection for any wireless frame. Refer to section: *Metered Throughput*.

For example, a single high-priority connection with bursty traffic may use up to 100% of the available bandwidth of a wireless frame, providing this does not exceed the Max. Sustained Rate in the current interval.

Within the same priority, precedence is given to connections that did not receive any additional bandwidth allocation (in Stage 3.2) in the previous wireless frame.

Within the same priority, bandwidth is allocated evenly between all connections if:

a) All connections are requesting their Max. Sustained Rate, and

b) The aggregate of all requests exceeds the remaining available bandwidth.

6.5.4 Stage 4: Subchannelization (AN-100UX Only)

This stage allocates bandwidth (as required) for servicing mandatory subchannelized connections. Refer to section: *Uplink Subchannelization*.

6.5.5 Stage 5: CPE Management (Unreserved)

This stage allocates all remaining bandwidth (as required) to service active SMC connections. Refer to section: Management Traffic (SMC).

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7

7 Operational Notes

7.1 Uplink Subchannelization (AN-100UX only)

The uplink subchannelization (USC) feature provides opportunities to increase sector uplink throughput and establish wireless links to medium and low signal subscribers. This feature is available for all subscribers running software v2.1 or higher.

Uplink Subchannels

In standard mode, the base station maps timeslots during which a single subscriber is permitted to transmit using all data subcarriers. The USC feature organizes the 192 data subcarriers into 16 groups. During each USC timeslot, selected subscribers are scheduled to transmit on 1, 2, 4, or 8 subchannel groups (see following table).

Table 54: Op Notes: Uplink Subchannelization Subchannel Group Assignment

Designation in SSInfo screen	1/16 [o]	1/8 [o]	1/4 [o]	1/2 [o]
Number of assigned subchannels	1	2	4	8

Concentrating the Tx power in subchannels provides a real gain of 7-10 dB in the subscriber uplink signal. This added gain enables use of higher modulations and can improve uplink throughput rates.

Table 55: Op Notes: Subchannelization Uplink Bandwidth Improvement

SS Info Label	USC Disabled	USC Enabled
Full	Up to 64 QAM	Up to 64 QAM
Optional	BPSK, QPSK, 16 QAM 1/2	Up to 64 QAM
Mandatory	No Link	BPSK 1/2 or QPSK 1/2

When USC is enabled, the base station classifies all subscribers based on the uplink signal quality (CINR, SNR, etc.). A column in the SS Info page identifies subscribers as 'full', 'optional', or 'mandatory', and indicates the number of assigned subchannels:

Full: Subscribers able to establish a 16 QAM 3/4 or 64 QAM link without USC are tagged as 'full' and are not included in any USC scheduling.

Optional: Subscribers with signal strength sufficient to establish BPSK or QPSK links without USC are tagged as 'optional'. These subscribers are candidates for traffic optimization. The increased gain available using the USC feature may enable these subscribers to transmit at modulations up to 64 QAM.

Mandatory: Subscribers that can not establish a stable wireless link without benefit of the increased uplink gain provided by the USC feature are tagged 'mandatory'. These subscribers will only transmit during USC scheduled timeslots. Traffic from these subscribers is scheduled as Best Effort (regardless of service flow settings) and the highest available modulation is QPSK 1/2.

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***IMPORTANT**: Units tagged 'mandatory' should not be considered 'in-service'. Depending on traffic conditions in the sector, 'mandatory' subscribers may not receive any bandwidth allocation for extended periods. This mode is provided to assist deployment and commissioning processes, and steps should be taken to improve the link budget for these subscribers before declaring them 'in-service'.*

Enable / Disable USC

The USC feature is enabled/disabled from the Wireless Interface page of the AN-100UX GUI or using CLI. For example, use the following CLI command to enable USC mode:

```
AN100UX#> interfaces wireless set MacSubchannelization 1
     where, 0 = Disabled, 1 = Enabled
```

7.2 Self-Provisioning Features

7.2.1 Default Service Flows

The base station automatically creates one default downlink service flow and optionally one default uplink service flow for each registered subscriber. The default service flows can pass initial traffic required for network entry (e.g., DHCP Discovery or PPPoE Initiation from hosts connected to the subscribers). Refer to 4.3.3: Service Flows on page 56.

7.2.2 Automatic UL Filtering

The Automatic Uplink filter implemented at the subscriber emulates bridge functionality to prevent local traffic from being transmitted upstream over the wireless interface.

7.2.3 Host Learning

The MAC learning feature allows the base station to automatically learn the MAC addresses of hosts (devices) on the Ethernet segment connected to a subscriber. The learning feature can be enabled individually for any subscriber and the number of learned hosts can be adjusted dynamically. MAC addresses are learned on a first-come basis. The subscriber does not age the learned MAC addresses -- the table is reinitialized only when the subscriber is rebooted.

Note: Enabling 'host learning' affects the function of downlink 802.3 classifiers (see Generic 802.3 DL Classifiers following). No other classifiers are affected. Remote management must be enabled (managedSS=1) on the subscriber.

7.2.4 Intra-Sector L2 Forwarding (iSL2F)

This feature supports layer 2 network connectivity between subscribers in a single sector (hair-pinning).

For the iSL2F feature to be functional, the following items must be properly configured:

1. **Ethernet Tagging**: The Ethernet Tagging (ethTag) function must be enabled on each participating subscriber. When enabled, this function identifies data traffic through this subscriber by using 802.1Q VLAN tags. Refer to the RedMAX Outdoor Wireless Access Subscriber Modem User Manual for details. The ethTag function can be configured only using the subscriber CLI commands.

2**. MAC Learning**: The Learning function must be enabled on the base station for each participating subscriber. The Learning feature allows the base station to automatically discover the MAC addresses of hosts (devices) on the Ethernet segment connected to a subscriber. Set the Max Hosts Number to learn up to sixteen hosts on the specified subscriber. Refer to section 4.3.1: Subscribers on page 51.

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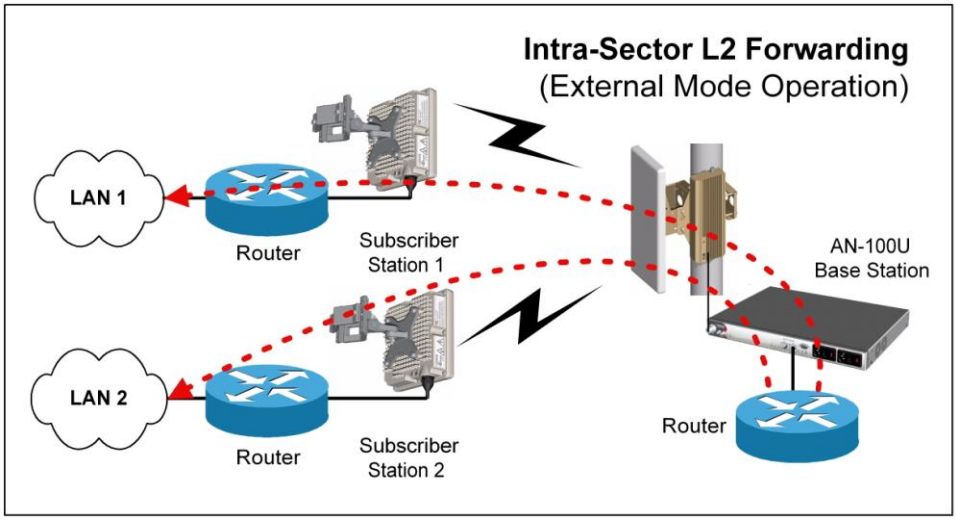

Figure 40: Op Notes - Intra-Sector Layer 2 Forwarding -- External Mode

External Mode: When external mode selected, the base station accepts traffic resubmitted to the Ethernet port. This permits an external L2 switch to forward traffic between hosts located behind subscribers in the same sector. The L2 VLAN switch must have the capability to forward traffic back through the originating Ethernet port. This capability is not supported by all Ethernet switches, but may be possible through specific VLAN-to-Ethernet port mappings or by VLAN switching.

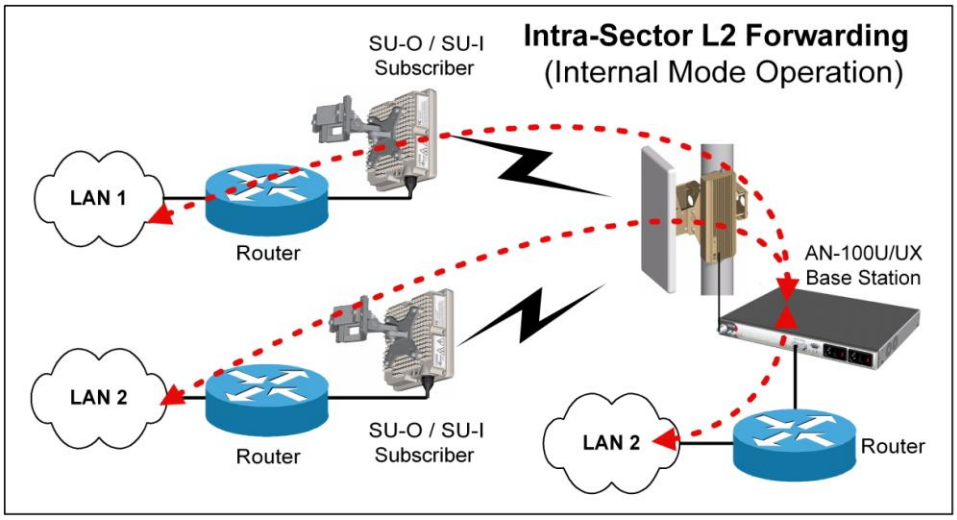

Figure 41: Op Notes - Intra-Sector Layer 2 Forwarding -- Internal Mode

Internal Mode: When internal mode is enabled, the base station classifies and forwards traffic between hosts located behind subscribers in the same sector (hairpinning) without an external switch. Subscriber traffic arriving at the base station appears on the Ethernet port and is also resubmitted to the MAC for reclassification and broadcast over the air.

On the AN-100U/UXthe service is established by defining a service flow to act as a transparent tunnel for higher layer protocols (i.e. ARP, IP, SNA). VLAN tags, inserted by the subscriber unit are used to uniquely identify members of a shared VLAN. The base station establishes individual forwarding rules for each virtual LAN as identified by the VLAN VID field.

Tagged traffic is transmitted from the subscriber to the base station, where each VLAN tag (specifically the VID) is inspected in each frame and forwarding rules are applied.

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Traffic arriving at the base station from subscribers appears on the Ethernet port as well as being resubmitted to the MAC for reclassification and broadcast over the air.

Disabled Mode: When the Intra-Sector L2 Forwarding feature is disabled, the base station will not forward traffic between subscribers (hairpinning) and will not accept traffic resubmitted to the Ethernet port by an external switch.

7.2.5 DHCP Option 82

The DHCP option 82 support can be used by equipment upstream of the RedMAX base station to uniquely identify when customer equipment located behind a subscriber issues a request for network access (DHCP request for an IP address). This information, used in combination with other network notification messages, allows network operators to be informed when customers activate self-install CPEs. Operations can then take manual or automated actions to authorize and activate the services for this subscriber.

The format of Relay Agent Option 82 option is as follows:

Circuit ID: MAC address of base station.

Remote ID: MAC address of subscriber.

GiAddr: Management IP address of base station (if added by upstream equipment).

Note: The subscriber CLI control 'dhcpRelayAgent' must be enabled prior to using the Option 82 feature.

7.3 Privacy Layer -- Encryption

7.3.1 Overview

The RedMAX AN-100U/UX base station and SU-O/SU-I subscribers support the privacy sub-layer as defined in the IEEE 802.16-2004 standards. The process of modem authentication and message exchange for user traffic encryption is described fully in the IEEE 802.16-2004 standards.

Authentication uses Public Key Infrastructure (PKI) technology-based X.509 digital certificates and the RSA (Rivest-Shamir-Adleman) public-key encryption algorithm. The current software release supports the Data Encryption Suite (DES) cryptographic suite with exchanged Traffic Encryption Keys (TEKs) secured using 3DES (TEKs are triple encrypted using three keys in succession).

The authentication process is performed by the base station and does not require external Authentication, Authorization, and Accounting (AAA) servers (e.g. RADIUS, TACCACS, LDAP, etc). The authentication process ensures subscriber modems are genuine Redline devices and not rogues introduced into the wireless sector area.

If authorization is successful, the base station sends the customer subscriber an encrypted authorization key using the subscribers public key. This key is used to encrypt transmissions to the base station. At the end of the authentication process the subscriber has a shared AK (Authentication Key), which is used to derive TEKs. Management messages between the base station and subscriber modem are protected with a Keyed-Hashing for Message Authentication (HMAC) digest to ensure the data from the sender has not been altered.

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7.3.2 Configuring the Base Station

Obtaining Base Station X.509 Certificates

When using privacy, you must obtain and load the following two X.509 certificates:

Redline_Communications_Root_CA_509.cer

Redline_Communications_Root_CA_R_509.cer

These certificates are available from your Redline Certified Partner.

Important: It is recommended to ensure that both certificates are pre-loaded on all sectors using privacy. This will ensure privacy support is available when new or replacement subscribers (running v2.2 or higher) are installed in a sector.

Privacy Settings (TrustAll)

The privacy feature is always enabled on the base station, but is individually enabled or disabled on each subscriber. When a subscriber has privacy enabled, the TrustAll parameter setting determines the mode of authentication. Refer to the following table for details. Changes to the TrustAll setting are effective only after rebooting the base station.

Table 56: Op Notes - Base Station TrustAll Setting

TrustAll	Base Station
No (0)	A Root CA must be loaded on the base station. The base station enforces the full validation process. **Important**: When the base station TrustAll setting is 0 (no), subscribers with privacy enabled can not be authenticated unless the operator has loaded a Root CA on the base station.
Yes (1)	Requires a Root CA file to be loaded on the base station. Authentication is successful if the subscriber presents a correctly formatted certificate (base station does not enforce the entire validation process).

Important: The privacy command UseTestTimes is for factory testing only. Do not change the default setting (0) for this parameter.

Base Station Certificates

The base station can be configured to require a Root certificate for authentication, or to authenticate any subscriber presenting a correctly formed certificate (see base station TrustAll parameter). The Redline Root CA (issued by Verisign) can be loaded on the base station and used to authenticate Redline subscriber modems (but not modems with certificates by third-party vendors).

Examining Base Station x509 Certificates

Certificate commands are located in the 'x509' group of CLI commands. Use the show command to display the X.509 certificates (if available).

Example #1: No Root CA has been loaded (default).

```
AN100U#> x509
AN100U(x509 ->)#> show
(Empty)
AN100U(x509 ->)#>
```


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Example #2: Operator has successfully loaded a Root CA.

AN100U#> *x509 show <ENTER>*

Index #0:

Subject:

C = CA, O = Redline Communications Inc, CN = Redline Communications Inc

Root CA Issuer:

C = CA, O = Redline Communications Inc, CN = Redline Communications Inc

Root CA Validity:

Not Before: Oct 28 00:00:00 2010 GMT

Not After: Oct 27 23:59:59 2040 GMT

AN100U#>

Loading x509 Certificates

Use the following procedure to add (or replace) the X.509 Root CA on the base station.

FTP Server Setup

1. An FTP server is required for all upgrades. The FTP server must be located on the network connected to an active Ethernet port (Data or Mgmt) on the base station.
2. You must copy the X.509 certificate(s) to the default file location on the FTP server (you can not specify a pathname in the CLI dialog).

Load Certificates on Base Station

1. Open a Telnet session to the base station.
2. Use the x509 CLI command 'add' to load the certificate. You will be prompted to enter a username and password for the FTP server.

   x509 add <FTP_IP> <CERTIFICATE_NAME>

   Where,

   <FTP_IP> is the IP address of your ftp server.

   <CERTIFICATE_NAME> is the name of the x.509 certificate file.

   Example:

   user name: target

   *password: ******

   X509LoadDownloading ...

   AN100U#>
3. Use the 'show' command to confirm the x.509 certificate was successfully loaded.

   x509 show

Note: Installing a certificate does not automatically activate privacy on the subscribers.

Advanced Configuration

The following table indicates the default privacy timer settings. The base station must be rebooted to make changes effective.

Important: These settings should be modified only by network administrators having advanced knowledge of encryption systems (see section 7.3.3: Configuring Subscribers on page 119). Changes to these setting may cause the system to stop exchanging data over the wireless interface.

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Table 57: Op Notes - Base Station Advanced Privacy Settings		
Parameter	**Default (sec)**	**Description**
AKLifetime:	604800	Period the subscriber is authenticated (168 hours).
TEKLifetime:	180	Period during which each key is valid.
AuthGraceTime:	600	Period allowed to obtain reauthorization before current session ends.
TEKGraceTime:	60	Period allowed for remote device to process the request for a new TEK.
ReauthWaitTime:	10	Period to wait for confirmation of reauthorization request.
AuthRejWaitTime:	10	Period to wait after rejection of authorization request.
OpWaitTime:	1	Retransmission interval when requesting new TEK.

7.3.3 Configuring Subscribers

Each wireless subscriber modem contains one built-in certificate for itself and one for the manufacturer. Encryption must be enabled separately for each participating subscriber. The mode of authentication must be configured on the base station (see TrustAll parameter).

Table 58: Op Notes - Privacy Settings	
privacySS	**Description**
0 (No)	Privacy is enabled -- authentication is required.
1 (Yes)	Privacy is disabled -- authentication is not required.

Example: Enable privacy for subscriber:

SUO#> privacySS

SUO(privacySS ->)#> set Enabled 1

To disable privacy module in SS follow these steps:

SUO#> privacySS

SUO(privacySS ->)#> set Enabled 0

7.4 Co-Channel Operation

Greater complexity in the modulation technique requires a greater (C/N) ratio to maintain adequate throughput. In the presence of an interferer, the useful signal is degraded. The ratio of 'useful signal' to 'interfering signal' is called the carrier-to-interference ratio. If the interferer signal power is additional noise power, and the overall C/I+N ratio can be estimated as:

$CINR = C/I + C/N - 10\log(10^{\frac{C/I}{10}} + 10^{\frac{C/N}{10}})$, where all variables are in decibels.

This formula corresponds with an expectation that a very strong signal (high C/N) is able to withstand higher levels of interference (low C/I). If the signal is weak, even low interference levels will significantly degrade the useful signal. Consider the following examples:

Case 1: The threshold CINR for 64 QAM 3/4 is around 23.25 dB. If the C/N ratio is 24 dB, the system will operate at 64 QAM 3/4 (signal is close to the 64 QAM 3/4 threshold, but still above it). If we introduce an interferer with a signal 30 dB weaker than the

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system signal (i.e., C/I = 30 dB), the overall CINR will drop to around 23 dB, forcing the system to change the modulation rate to 64 QAM 2/3.

Case 2: If the signal is very strong and the C/N ratio is around 28 dB, it will require a much stronger interferer to force a drop in modulation. According to the formula above, for a C/N of 28 dB, the C/I should be 25 dB in order to force a drop in modulation. In this case the interferer was 5 dB stronger than the first case.

The following table lists experimentally obtained minimal C/I ratios required for the system to not change modulation:

Table 59: Op Notes - Co-channel C/I dB Measured Results

Modulation/Coding	CINR threshold dB	C/I: Case 1 dB	C/I: Case 2 dB
64 QAM 3/4	23.25	34	24.4
64 QAM 2/3	21.75	32	22.7
16 QAM 3/4	18	28	18.2
16 QAM 1/2	15	26	16.4
QPSK 3/4	11.6	21	12.1
QPSK 1/2	6.75	19	9.4

In case 1 the signal is already very close the threshold rate (C/N is less than 1 dB above the CINR threshold) and even weak interference can force the system to change to a lower modulation. A moderately high C/I ratio is required for the modulation to remain unchanged.

In case 2 the signal is very strong (C/N is more than 10 dB above the CINR threshold) and can experience more severe interference without being forced to change modulation.

The amount of interference required to force the system to go to the lower modulation rate in these two extreme cases is very different, and in an actual deployment scenario a full range of results are possible. Careful planning is necessary when frequency reuse is required, and sufficient fade margin must be included to anticipate fluctuations of both C/I and C/N.

7.5 Interference Issues

7.5.1 General Interference

Redline has introduced several techniques to mitigate interference issues:

1. OFDM: multiple carriers using both time and frequency diversity to provide high tolerance to co-channel and adjacent channel interference, remove inter-symbol interference (ISI) due to multipath and recover data from carriers falling in regions of deep channel fades.
2. Multiple channels (twenty-eight non-overlapping at 3.5 MHz) for diversity and interference mitigation.
3. Adaptive modulation using six transmission rates to suit varying link conditions.
4. Adaptive encoding is heavily coded to substantially increase robustness. State of the art forward error correction (FEC) using Convolutional-coding gives the base station superior frequency selective fading mitigation capability.
5. Narrow beam antennas with high sidelobe and backlobe isolation and very low VSWR.
6. Antenna cross-polarization enabling equipment co-location as well as effective frequency planning.

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7. High receiver dynamic range to address dynamic interference.
8. State of the art filtering at the RF, IF and baseband levels to reduce interference.
9. Choice of non-adaptive modulation to provide stable burst rate during periods of rapid interference variations on the link.

7.5.2 Multipath Interference

The base station is designed with high immunity to interference and multipath signals. Its core technology is Orthogonal Frequency Division Multiplexing (OFDM), capable of reliable performance under multi-path and frequency selective fading known to have severe signal fading and distortion effects in the sub-11 GHz frequencies.

Multipath interference is a significant problem in long-range links, and in near line-of-sight, and non line-of-sight links. Multipath is a form of self-interference occurring when signal reflections arrive slightly later than the primary signal. The result can be destructive interference that can essentially null out the primary signal or overlap the original signal such that it cannot be decoded. Multi-path interference is a problem with long-range links where reflections off the ground, snow, and water frequently interfere with the primary signal. It is also a problem in urban environments where the signal reflects off buildings, trees, and roads.

OFDM breaks up the transmit signal into many smaller signals. For example, instead of one single carrier carrying 70 Mbps of data (wireless interface rate), there are 192 separate carriers, each carrying about 364 Kbps of data (in the case of the Redline product) in a 14 MHz bandwidth. If selective fading degrades one or two carriers, the impact is minimal since the information is spread across the remaining carriers.

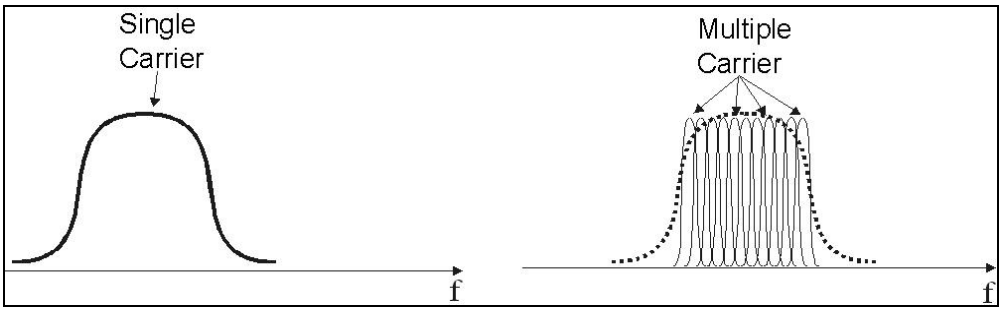

Figure 42: Op Notes: OFDM Multiple Carriers

One key aspect of OFDM implementation is that the individual carriers overlap significantly to preserve overall bandwidth. Normally, overlapping signals would interfere with each other, however, through special signal processing, the carriers in an OFDM waveform are orthogonal to each other.

Multipath interference may cause individual narrowband channels to be altogether lost. This problem is addressed in the Redline implementation in three ways:

1. Equalizing the received signal based on an estimate of the channel fading conditions (restoring the faded sub-channels).
2. Interleaving the data before modulation onto the individual sub-channels (so that adjacent data symbols do not necessarily end up on adjacent sub-channels, and thus deep fades do not impair large chunks of the signal).
3. Convolutional encoding of the input data introduces correlations between signal samples that are echoed on sub-channels occurring in separate parts of the spectrum. This allows the receiver to infer the values of the signal that were transmitted on fatally faded sub-carriers. The key advantage of multiple carriers is that the signal is more robust to multipath disturbance, as described below.

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OFDM equalization and coding techniques cannot overcome all forms of sharp, multipath-related fading. For additional robustness, the OFDM implementation uses a guard interval between each of the sub-channels. This guard interval is filled with redundant data taken from the end of the same channel symbol and repeated at the beginning of each channel symbol. Multipath echoes from each individual sub-channel overlap the guard interval, rather than overlapping data in other symbols. Used in conjunction with adaptive equalization, coding, and modulation, use of the guard interval provides reliable operation in a wide class of non line-of-sight environments.

7.5.3 Calculating Receive Sensitivity (WiMAX Testing)

The WiMAX test for receive sensitivity modifies the methodology from 802.16 to allow results to be obtained easier and faster. The standard Bit Error Rate (BER) of 1x10-6 remains the benchmark for these calculations. The BER is obtained by measuring Packet Error Rate (PER), but PER cannot truly be measured (it is a limit) and requires that a test be performed to estimate the PER value. Larger sample sizes will produce more accurate values for PER. There is a practical limit to the size of the test sample, and WiMAX has chosen the number of packets in the sample to enable result that will approximate a BER lower than 1x10-6.

Sample Test for Subscriber Receive Sensitivity

1. Connect packet generator to the base station-to-subscriber link and then configure packet generator to send 50,000 Ethernet packets with payload of 288 Bytes (i.e., total Ethernet packet size is 288 + 18 = 306 Bytes). Payload should not be chosen by the packet generator, but must be filled with the pattern defined in the WiMAX standard. The packets should be sent at a rate to fill at least 80% of the downlink (DL) frame.
2. Count the number of packets received. If less than 97 packets are lost, it can be stated with 95% confidence that the BER is 1x10-6 or lower.
3. Repeat the test by sending 20,000 Ethernet packets with payload of 864 Bytes. If less than 118 packets are lost, it can be stated with 95% confidence that the BER is 1x10-6 or lower.
4. You repeat the test by sending 10,000 Ethernet packets with payload of 1488 Bytes. If less than 100 packets are lost, it can be stated with 95% confidence that the BER is 1x10-6 or lower.
5. Receiver sensitivity is defined as the lowest RSSI value tested where samples for all three packet sizes did not exceed the maximum number of lost packets. The 95% confidence level indicates that if the test is repeated multiple times, you will obtain passing results 95 times out of 100.

Refer to the following table for a summary of the test parameters.

Table 60: **Op Notes: Receive Sensitivity Tests** (95% Confidence)

Equivalent BER	Packets Sent	Payload Size	Max. Packets Lost
1x10-6	10,000	1,488	100
	20,000	864	118
	50,000	288	97
1x10-9	60,000	1,488	57
	100,000	864	55
	300,000	288	100

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7.6 RedMAX Backhaul Application

The RedMAX equipment can be configured to operate as a PTP backhaul link to provide backhaul services to a remote location (e.g., RedMAX PMP network). This can reduce capital and operational expenses (training, spare parts, etc) when compared to purchasing other models or manufactures equipment to provide this service. There are no hardware, software, or configuration changes required for any RedMAX subscriber or base station used for backhaul operations.

7.6.1 Base Station Configuration

There are three specific configuration settings required to enable the RedMAX base station for backhaul operation (no configuration change is required for the subscriber).

Service Class

Create one service class with the following settings:

SC Name: **Backhaul**

Scheduling Type: **BE**

Traffic Priority **0**

Max Sust Rate **25400000**

Service Flows

Click **Service Flows** in the menu (left side of screen) and create two service flows with the following settings. Enter the following settings for the upstream service flow.

SS Name: [subscriber name]

Direction: **upstream**

SC Name: **Backhaul**

Cs Specification: **802.3 Ethernet**.

Enter the following settings for the downstream service flow.

SS Name: [subscriber name]

Direction: **downtream**

SC Name: **Backhaul**

Cs Specification: **802.3 Ethernet**.

Classifiers

Click **Classifiers** in the menu (left side of screen) and enter the same settings for the upstream and downstream service flows:

DestMacAddr: Check ☑ to enable field. Enter a value of all zeros (00:00:00:00:00:00).

DestMacMask: Enter a mask of all zeros (00:00:00:00:00:00).

Synchronization

Click **Wireless Interface** in the menu (left side of screen) and select the following settings in the MAC Parameters section of the page:

Adaptive TDD: Check ☑ box to activate dynamic uplink/downlink setting. A log message is created when Adaptive TDD is enabled and disabled. This feature is enabled only when **Synchronization Mode** = **No Sync**.

Synchronization Mode: **No Sync** The synchronization function must be disabled to enable use of the Adaptive TDD.

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8

8 Troubleshooting

8.1 System Behavior

8.1.1 Base Station

1. Use of the secondary management channel (SMC) must be included in calculations for the maximum aggregate uplink and downlink throughput rates.
2. A duplex mismatch between the base station or subscriber Ethernet port and the connected Ethernet device may cause a lockup condition resulting in loss of data connectivity over the Ethernet port. This issue can occur only if one device is set for auto-negotiate and the other device has a manually set speed and duplex. Reset the base station or subscriber to restore operation. For highest availability, configure both Ethernet devices for the required speed and duplex.
3. The base station wireless downlink/uplink ratio combinations are dependant on the current CP and Frame Duration settings.
4. Base station CLI commands will not function with subscriber names containing space characters (blanks or white space). Use the Web GUI (or RedMAX RMS) to edit subscriber names and remove any blank characters.
5. Continuous high-volume streams of CLI commands may cause the base station to reset. It is recommended to insert one 'sleep 1' command for each 100 commands issued to the base station and to use only one Telnet session when running CLI scripts.
6. Continuous high-volume streams of SNMP commands may cause the base station to reset. When using 3rd-party SNMP-based devices, insert a pause between SNMP commands to allow sufficient processing time for the base station. It is strongly recommended to configure only one RedMAX RMS system to monitor a base station.
7. An event log (and syslog) message notification is sent whenever a pass-all classifier is created for downlink service flows.
8. When using adjacent channels on collocated base stations, the Noise Level indication on the Status screen may include signals from another base station.
9. When configuring UGS services on the base station, setting Max. Res BW or Min. Res BW to zero (0) designates 'unlimited' bandwidth -- all subscriber bandwidth will be allocated to this service flow (definition according to the 802.16.d standard).
10. The IP address field on the base station SS Info page is not populated until there is activity on the secondary management channel (SMC) to that subscriber. The SMC is not activate during subscriber registration, and some period of time may pass before the SMC is activated (e.g., SNMP message from RMS). If required, an operator can activate the SMC by opening a Telnet session to that subscriber via one of the sector controller Ethernet ports.
11. When a base station software image is activated (switch software versions), the current running configuration is overwritten with the configuration saved at the time

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the upgrade performed. Resetting the base station before activating a new software upgrade will cause the latest configuration to be loaded.

12. When using local synchronization (no GPS clock) and the Master is powered off or disconnected, rebooting the Backup-Master causes it to enter Slave mode and it does not generate synchronization pulses. The Backup-Master function is enabled only when synchronization pulses are detected from a Master (Sync out) or GPS clock (Sync in). If the Master will be out of service for an extended period, it is recommended to configure one of the Slave base stations to be a Master (requires a reboot).
13. Normal classifiers have preference over pass-all classifiers on the same priority level.

8.1.2 Subscriber

1. When upgrading, do not reset or remove power from the subscriber units immediately after the initial reboot. The software upgrade may require a minimum of two minutes to complete the re-programming. If the upgrade process is interrupted the subscriber may become unmanageable and the unit must be returned to the factory for repair.
2. Upgrading the subscriber from v1.0.x to v2.0.x using the subscriber Ethernet port may result in the subscriber being unable to reboot. The previous software version can not be restored. Any subscriber that fails during the upgrade process must be returned to the factory for reprogramming. It is strongly recommended to use the RedMAX RMS or the secondary management channel (SMC) from the base station (CLI over-the-air) to upgrade subscribers from v1.0.x to v2.0. BUG 2351
3. Loading an earlier software version causes the subscriber to load factory default parameters (including radio frequency settings). This may cause loss of connectivity with the base station. Use the CLI 'switch' command to return to the previous software version (only while the previous version resides in the alternate non-volatile RAM).
4. If the BsID table is not populated, rebooting the base station may cause the subscriber to switch to another base station and not return to original base station.
5. Uploading an invalid binary image (e.g., base station binary image) causes the subscriber to reject subsequent attempts to upload the correct binary file. Reboot the subscriber and upload the correct binary image file.
6. Uploading the SUO-U1-001-01-00-117.bin binary image to an SU-I will cause the unit to become inoperable. The SU-I must be returned to the factory for reprogramming.
7. The subscriber does not inform the user that a reboot is required before changes to RF parameters effective (e.g., channel, CP).
8. Following a power-cycle, the base station may not recognize the radio type for some early TB3335F7 and TB3436F7 radios. Power-cycle the system to clear the problem.
9. When using CLI to enter frequency ranges, all entries must be manually ordered from lowest (table entry 0) to highest.
10. Downgrading is possible if the previous version is still located in flash RAM (switch versions in the configuration screen). Downgrading from v2.0.x to v1.1.x may result in the subscriber being unable to reboot and the previous software version can not be restored. Any subscriber that fails during the downgrade process must be returned to the factory for reprogramming. 2923

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11. IF-MIB (RFC 2863) MIB ref: 1.3.6.1.1.1 statistics are not supported in SU-O/SU-I v2.0. Refer to the following list of SNMP MIB objects:

ifInErrors	ifInErrors	ifInUnknownProtos	ifHCInOctets
ifInMulticastPkts	ifInBroadcastPkts	ifInBroadcastPkts	ifOutMulticastPkts
ifInOctets	ifInOctets	ifInUcastPkts	ifOutBroadcastPkts
ifInUcastPkts	ifInDiscards	ifInDiscards	ifHCInOctets
ifInUnknownProtos	ifOutOctets	ifOutOctets	ifHCInUcastPkts
ifName-->Signal	ifName-->Data	ifInMulticastPkts	ifHCInUcastPkts
ifOutDiscards	ifOutErrors	ifOutErrors	ifOutBroadcastPkts
ifOutUcastPkts	ifOutUcastPkts	ifOutDiscards	ifOutMulticastPkts

8.2 Secondary Management Connection (SMC)

The SMC is used to exchange management traffic between the base station and subscribers (e.g., statistics and software downloads). A minimum downlink rate of 256 Kb/s is shared between all managed subscribers in a sector. A minimum uplink rate of 32 Kbps is provided on a per-subscriber basis. Additional uplink and downlink bandwidth available data scheduling is also made available to the SMC.

8.3 Factory Default Settings

The table lists some important factory default settings for the base station terminal.

Table 61: Troubleshooting - Factory Default Settings

Setting	Sub	Field	Value
Ethernet Interface		Management	Via Data port (integrated)
Management Interface		IP Address	192.168.101.3
Wireless Interface	RF	Frequency	3448000 KHz*
Wireless Interface	RF	Reference RSS	69 dBm
Wireless Interface	RF	Tx Power	0 db
Wireless Interface	PHY	Channel size	3.5 MHz
Wireless Interface	PHY	Guard Interval	1/4
Wireless Interface	MAC	Adaptive DL/UL Ratio	Disabled
Wireless Interface	MAC	Cell Range Km	5
Wireless Interface	MAC	DL Ratio	54
Wireless Interface	MAC	Frame Duration	10 msec
Wireless Interface	MAC	Synchronization Mode	No sync
Admin Login		Login Password	admin admin
Guest login		Login Password	guest guest
Debug Login		Login Password	debug redline

*Based on 3-4-3.6 GHz radio.

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8.4 Front Panel Diagnostics

Figure 43: Diagnostics: AN-100UBase Station Front Panel View

8.4.1 System LEDs

The front panel of the terminal includes a number of LEDs to monitor operation of the system and assist troubleshooting. Refer to section 3: Physical Description on page 28.

8.4.2 Console Port

The front panel includes the Console port. Use the CLI commands to interrogate the base station status and program most system settings.

8.4.3 System Reset Switch

Throughout this section, reference is made to the reset switch, which is a micro-switch recessed in the front panel in the system block. Use a small narrow object, such as a paper clip, to access the switch.

Depressing the reset switch for less than five seconds activates a short-reset (equivalent to power-cycle). Statistical values are reset.

Depressing the front panel reset switch for more than five seconds activates a long-reset. A long-reset reloads the factory defaults for the IP Address, IP subnet mask, password, and statistical values are reset.

8.5 Detecting Channel Interference at Startup

Following a power-cycle or reboot, the base station monitors the RF Channel to detect interference on the uplink channel. The transceiver is set to receive mode and the PHY is programmed to receive a long preamble from a WiMAX base station. If no preamble is detected during the one-second interval, the channel is considered free of interference from other WiMAX equipment.

If a long preamble is received, the base station continues to monitors the channel for an additional three seconds. If an 802.16d DL-Map is received, the following message will be entered into the event log:

WARNING: RF Channel Conflict with [BS Id]

This message in the event log indicates that another base station has been detected using the following RF-PHY characteristics:

- Same DL channel frequency as the UL channel frequency of this SC
- Same Cyclic Prefix
- Same channel size (i.e., 7 MHz)

If a long preamble was received, but no DL-Map was detected, the following message will be entered into the event log:

WARNING: Unknown Interference was detected on the UL channel

This second message does not necessarily indicate interference from another base station, and may be the result of cross-interference from subscribe stations.

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8.6 Recovering a Lost IP address

Use a DB-9 serial cable to access the base station serial console. The configuration of the serial port should be 57,600 bps, no parity, 8 data bits, 1 stop bit. Once connected, type in the command ifShow and read the value of inet under the idt interface.

8.7 Troubleshooting the Web Interface

These troubleshooting steps assume that the status LEDs on the front panel of the terminal indicates normal function.

1. Open a Web browser and attempt to login to the base station terminal. If the terminal does not respond by displaying the login dialog box, check that the correct IP address is being used. The factory default address is listed in the Troubleshooting section. The IP address may have been changed during installation. For correct operation the host computer and the terminal must appear to be on the same subnet. Ensure that the IP address for the PC is set to the same subnet as the terminal. For example, the IP address should only differ in the last octet (i.e., 192.168.101.X).
2. The next test is to verify the IP address is reachable from the computer. Use the ping command to test the connection between the terminal and host computer. The system always responds to ping frames less that 577 bytes in length.

   If the ping test is successful the host computer was able to send and receive packets. The problem may be with the Internet browser or related settings on the host computer. Re-boot the host computer to try to resolve the problem. If the ping is not successful, the IP address may be incorrect, or a duplicate address may exist.
3. If the current address of the terminal cannot be determined, it is recommended to perform a long-reset. Performing a long-reset restores the terminal IP address and IP Subnet Mask to the factory default values.

   Important: The long reset operation will restore many operating parameters to factory default settings.

Table 62: Troubleshooting - Web Interface Diagnostics

Symptom	Possible Problem	Solution
Login screen cannot be accessed.	Incorrect IP address and/or Subnet Mask.	Perform a ping test from the host computer command line. If the ping test is unsuccessful, then the problem is with the IP address. Perform a long-reset to restore the default address.
	Problems with host computer, or terminal.	If the ping is successful, reboot of the base station and/or host computer.
	Host PC ARP table is incorrectly configured.	Run 'arp -d' whenever connecting to a different base station terminal. Check that the subnet mask for the host PC matches the subnet mask of the terminal. Check that the host PC address is in the same subnet.

8.8 Re-Ranging Log Message

The log message 're-ranging' is recorded by the base station when a registered subscriber initiates a network entry sequence.

There are two common reasons for this event:

1. When network entry is complete, the subscriber retains its 'registered' state by sending data traffic to the base station. When there is no data traffic, the SU-O sends only periodic ranging requests each 25 seconds. Under no-traffic conditions, it may

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take the base station more than 25 seconds to declare a subscriber unavailable and mark it as de-registered. During the same 25-second period, the subscriber may declare the base station to be unavailable (i.e., due to poor link conditions) and begin attempts to re-register. In this scenario, the subscriber is attempting to re-register before the base station has declared the subscriber to be failed.

2. This condition may also result from a loss of connectivity between a subscriber and the DHCP server or TOD server. When remote management is enabled on the subscriber (managedSS=1), the subscriber must communicate with the DHCP server and the ToD server specified in the obtained lease. If communication cannot be established within two minutes, the subscriber MAC is rebooted and the attempt repeated.

8.9 Replacing the System Fuse

Important: *Always completely remove power from the base station before performing any maintenance on the terminal or modem.*

	Warning to service personnel: **Caution for all AC and DC models – Double Pole/Neutral fusing.**

To replace fuse:

1. Disconnect power from the terminal.
2. Pry off the black plastic cover located on the back panel beside the power switch and extract the red fuse holder. Use an approved tool to remove the glass-cased fuses from the holder. Be certain to replace the fuse(s) into the lower half of the holder, as shown in the diagram below. The fuse holder holds two fuses, both of which are active. Be certain to use fuses of the same type and rating.
3. Replace the fuse holder in the system terminal and secure.
4. Restore power to the base station.

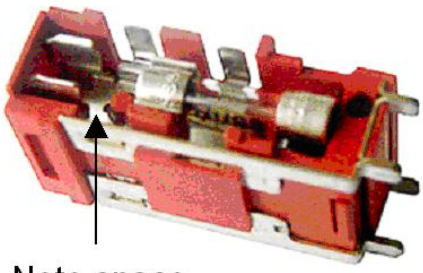

Figure 44: Diagnostics: Base Station Power Supply Fuse Holder

Table 63: Troubleshooting - Fuse Ratings

Symptom	Power Supply Type	Fuse Rating
AN-100U	AC	2.5 Amp, 5 x 20 mm, time delay glass tube
	DC	4.0 Amp, 5 x 20 mm, time delay glass tube
AN-100UX	AC	2.5 Amp, 5 x 20 mm, time delay glass tube
	DC	5.0 Amp, 5 x 20 mm, time delay glass tube
	Redundant DC	5.0 Amp, 5 x 20 mm, time delay glass tube

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8.10 RF Troubleshooting

The terminal monitors the status of the outdoor modem and reports any fault conditions in the system event log. The following table lists the general fault conditions reported by the terminal.

Table 64: Troubleshooting - RF Error Diagnostics

Error Type	Description
IF PLL Unlocked	The PLL (Phase Locked Loop) section within the terminal experienced an error. The System Fault LED may light. Try rebooting the base station.
Communication Error Over IF Cable	Communication between the terminal and the modem failed. Check the IF cable and connectors.
Outdoor Unit Temperature is too High. Air Interface Disabled for 15 Minutes	The internal temperature of the modem is above 82C (180°F). The modem shuts down to allow cooling.
Outdoor Unit Power Supply Error	Displays a fault in the modem power supply. This error could be due to a problem with the internal power supply or with the power source from the terminal. If the 'Low DC Voltage At Radio' error is also indicated, (see below) check the IF cable and connectors. If the 'Low DC Voltage At Radio' error is not indicated, the modem requires servicing.
Outdoor Unit 24V Error	The DC voltage at the modem (carried by the IF cable from the terminal) is lower than the required 24 VDC. Check the IF cable and connectors. The minimum required voltage for operation is 12 VDC.
Air Interface Disabled	The radio is disabled.
Cable Compensation Failed	The measured IF cable compensation is out of specification.
Invalid Radio	The attached radio is not compatible with this terminal/configuration.
Outdoor Unit 3.3V Error	The modem internal power supply is lower than the required 3.3 VDC.

8.11 Debug Mode

Debug mode is used for factory test and advanced troubleshooting. Logging in to the Web GUI or Telnet session using the debug username and password provides access to advanced configuration controls. Debug mode should be used only under the explicit direction of Redline field service or their representatives. It is recommended to change the debug mode default password to restrict access to this feature.

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9 Appendices

9.1 Glossary

Term	Acronym	Definition
Authentication, Authorization, and Accounting	AAA	AAA servers (e.g. RADIUS, TACCACS, LDAP, etc) qualify requests for access to computer resources.
Active Service Flow	-	An Admitted Service Flow that is active and available for packet transmission.
Address Resolution Protocol	ARP	An IETF protocol for converting network addresses to 48-bit Ethernet addresses.
Admitted Service Flow	-	Service Flow is registered, but not active.
RedMAX Base Station System		The base station terminal, modem, and antenna.
RedMAX Base Station Terminal		The base station indoor unit.
Antenna Gain	-	The measure of antenna performance relative to a theoretical antenna called an isotropic antenna.
Base Station	BS	The RedMAX base station terminal configured as central equipment (also referred to as a base station).
Beamwidth	-	The angle of signal coverage provided by an antenna.
Best Effort Service	BE	BE service provides efficient service to best effort traffic. In order for this service to work correctly, the Request/Transmission Policy setting should be such that the Subscriber is allowed to use contention request opportunities. This results in the Subscriber using contention request opportunities as well as unicast request opportunities and unsolicited Data Grant Burst Types. All other bits of the Request/Transmission Policy are irrelevant to the fundamental operation of this scheduling service and should be set according to network policy. The key service elements are the Minimum Reserved Traffic Rate, the Maximum Sustained Traffic Rate, and the Traffic Priority.
Binary Phase Shift Keying	BPSK	BPSK is a digital modulation technique. This type of modulation is less efficient than similar modulation techniques such as QPSK and 64 QAM, but is less susceptible to noise.
Bps	Bps	A unit of measurement for data is transfer.
Broadband Fixed Wireless	BFW	High-speed wireless installation where the equipment is not mobile.

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Term	Acronym	Definition
Broadcast Addresses	-	A predefined destination address that denotes the set of all data network service access points.
Burst	-	A group of protocol data units (PDUs) transmitted over the wireless link using the same profile.
Burst profile	-	Enter of settings that describe the uplink or downlink transmission properties associated with an Interval Usage Code. Each profile contains settings such as modulation type, forward error correction type, preamble length, guard times, etc.
CEPT		The European Conference of Postal and Telecommunications Administrations (CEPT) established in 1959. CEPT activities included co-operation on commercial, operational, regulatory and technical standardization issues.
Channel	-	A communications path wide enough to permit a single RF transmission.
CIR	CIR	Minimum Reserved Traffic Rate (see QoS)
CINR	CINR	CINR is the ratio of Carrier/(Interference + Noise).
Class of Service	-	Each Class of Service can be defined by a set of QoS settings.
Classifier	-	A set of criteria used for packet filtering which map each packet to the corresponding Service Flow (i.e., IP or MAC address).
Committed Information Rate	CIR	The minimum guaranteed bandwidth for a connection.
Concatenation	-	The act of combining multiple medium access control (MAC) protocol data units (PDUs) into a single burst.
Connection	-	A unidirectional mapping between RedMAX base station and subscriber medium access control (MAC) peers for transporting service flow's traffic. A Connection Identifier (CID) identifies connections. All traffic is carried on a connection, even for service flows that implement connectionless protocols, such as Internet Protocol (IP).
Connection Identifier	CID	A unidirectional, medium access control layer address that identifies a connection to equivalent peers in the medium access control layer of the base station and subscriber. A CID maps to a service flow Identifier (SFID), which defines the Quality of Service (QoS) settings of the Service Flow associated with that connection. Initial Ranging - A well-defined Connection Identifier that is used by a subscriber during the initial ranging process. This CID is defined as constant value within the protocol since a subscriber has no addressing information available until the initial ranging process is complete. Transport - unique identifier taken from the Connection Identifier address space that uniquely identifies the Transport Connection.
Cyclic Prefix	CP	Guard interval to resist multipath effect.
Data Link Layer	-	Layer 2 in the Open System Interconnection (OSI) architecture; the layer that provides services to transfer data over the transmission link between open systems.
DB	-	A ratio expressed in decibels.

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Term	Acronym	Definition
dBi	-	A ratio, measured in decibels, of the effective gain of an antenna compared to an isotropic antenna.
DBm	-	Decibels relative to a milliwatt
Data Encryption Standard	DES	Refers to the ANSI X3.92 and X3.106 standards. 3DES applies three keys in sequence to encrypt the data.
Directional Antenna	-	An antenna that concentrates transmission power into one direction.
Download Interval Usage Code	DIUC	An interval usage code specific to a downlink (from RedMAX base station to subscriber).
Downlink	-	The direction from the RedMAX base station to the subscriber.
Downlink Channel Descriptor	DCD	A medium access control layer message that describes the physical layer characteristics of a downlink channel.
Downlink Map	DL-MAP	A medium access control layer message that defines a map with burst start times. DL-MAP is the main message that defines synchronization of Subscriber. Based on the map Subscriber read and parse the Downlink information.
Downstream	-	Flow from base station to subscriber.
Downstream Classifier	-	Assigns packets to downstream service flows.
Dynamic Host Configuration Protocol	DHCP	An Internet protocol used for assigning network-layer (IP) addresses dynamically.
Dynamic service	-	The set of messages and protocols that allow base station and subscriber to add, modify, or delete the characteristics of a service flow.
Encryption	-	For the purposes of privacy, the transformation of data into an unreadable format until reformatted with a decryption key.
Ethernet	-	A LAN architecture using a bus or star topology
FCS	FCS	Frame Check Sequence.
FEC	FEC	Forward Error Correction
File Transfer Protocol	FTP	(Client and Server): Protocol implementing RFC 959 and running in NOC-S as Client and BSC as Server for transferring/replicating configurations files needed by local DHCPs.
Frame	-	A structured data sequence of fixed duration used by some physical layer specifications. A frame may contain both an uplink sub frame and a downlink sub frame.
Frequency Agnostic	-	Operating independently of the radio frequency selection.
Frequency Division Duplexing	FDD	A transmission method that separates the transmitting and receiving channels with a guard band (some amount of spectrum that acts as a buffer or insulator). In a framed (burst) FDD system, the uplink and downlink channels are located on separate frequencies and the downlink data can be transmitted in bursts. A fixed duration frame is used for both uplink and downlink transmissions.

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Term	Acronym	Definition
Full Duplex	-	Refers to the transmission of data in two directions simultaneously (i.e. a telephone)
Gain	-	The ratio of the output amplitude of a signal to the input amplitude of a signal. Typically expressed in decibels (dB).
Gateway	-	A network point that acts as an entrance to another network.
Gigahertz	GHz	1,000,000,000 Hz, or 1,000 MHz
Grant Per Connection	GPC	A bandwidth allocation method in which grants are allocated to a specific connection within a subscriber. Note that bandwidth requests are always made for a connection. A Subscriber can have multiple connections. In GPC mode, Subscriber request bandwidth for each connection.
Header Check Sequence	HCS	Header Check Sequence error. This is a CRC error on the header fields only.
Hertz	Hz	The international unit for measuring frequency, equivalent to the number of cycles per second. One megahertz (MHz) is one million Hertz. One gigahertz (GHz) is one billion Hertz.
Keyed-Hashing for Message Authentication	HMAC	RFC2104 - HMAC: Keyed-Hashing for Message Authentication
Information Element	IE	A component of the downlink or uplink map that defines the starting address associated with an IUC that identifies a certain burst profile.
ISI	ISI	Inter-symbol interference
Internet Protocol	IP	See TCP/IP
Interval Usage Code	IUC	A code identifying a particular burst profile that can be used by a downlink or uplink transmission interval.
Isotropic	-	A theoretic construct of an antenna that radiates its signal 360 degrees both vertically and horizontally—a perfect sphere. Generally used as a reference.
Latency	-	Delay
Lightweight Directory Access Protocol	LDAP	Internet protocol described in RFC 2251 and implemented in NOC-C, NOC-S and SR. It is designed to provide quick access to directories that contain information locally in attributes or externally in databases such as SQL. In our provisioning system LDAP is the engine that replicates, distributes, searches, reads and writes *Subscriber* information (CPE-NAMES, Service Flows).
Line Of Sight	LOS	A clear direct path between two antennas, with no obstructions within the first Fresnel zone.
Link Layer Control	LLC	Layer 2 Link Layer Control
Link Budget Tool		Software application to characterize the range performance for LOS, OLOS and NLOS conditions for selected system settings.
Local Area Network	LAN	A data communications network, typically within a building or campus linking computers, printers and other devices together.
Local Exchange Carriers	LEC	The traditional local wired phone company.

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Term	Acronym	Definition
Management Connection	-	A connection that is established during initial subscriber registration that is used to transport delay-tolerant medium access control management messages and even higher layer management and control messages. Each Subscriber has three management connections: basic, primary and secondary.
Media Access Control	MAC	A unique number assigned to a network device. It corresponds to the ISO Network Model Layer 2 data link layer.
Megahertz	MHz	1,000,000 Hz
Modulation	-	Any of several techniques for combining user information with a transmitter carrier signal.
Multicast polling group	-	A group of subscribers that are assigned a multicast address for the purposes of polling.
Multipath	-	The RF echoes created from radio signal reflections.
Network Time Protocol	NTP	Protocol for synchronizing a set of network clocks using a set of distributed clients and servers. It is implemented as Server on *BSC* for time synchronization with subscribers and base stations. Described in IETF RFC 958.
Non Line Of Sight	NLOS	Completely obstructed path between two antennas.
NVRAM		Non-volatile RAM memory. Does not lose its data when power is removed.
Non Real-Time Priority	nrt-PS	The nrt-PS is designed to support non real-time service flows that require variable size Data Grant Burst Types on a regular basis, such as high bandwidth FTP. The service offers unicast polls on a regular basis, which assures that the flow receives request opportunities even during network congestion. The RedMAX base station typically polls nrt-PS CIDs on an interval (periodic or periodic) on the order of one second or less. The key service elements are Minimum Reserved Traffic Rate, Maximum Sustained Traffic Rate, Request/Transmission Policy, and Traffic Priority.
Optical Line Of Sight	OLOS	A clear direct path between two antennas, with obstructions within the first Fresnel zone.
Orthogonal Frequency Division Multiplexing	OFDM	Orthogonal frequency-division multiplexing (OFDM) is a method of digital modulation in which a signal is split into several narrowband channels at different frequencies. The technology was first conceived in the 1960s and 1970s during research into minimizing interference among channels near each other in frequency. In some respects, OFDM is similar to conventional frequency-division multiplexing (FDM). The difference lies in the way in which the signals are modulated and demodulated. Priority is given to minimizing the interference, or crosstalk, among the channels and symbols comprising the data stream. Less importance is placed on perfecting individual channels.
Packet	-	A bundle of data organized in a specific way for transmission. The three principal elements of a packet include the header, the text, and the trailer (error detection and correction bits).
Packing	-	The act of combining multiple service data units (SDU) from a higher layer into a single medium access control protocol data unit MPDU.

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Term	Acronym	Definition
Physical Layer	PHY	Provides for the transmission of data through a communications channel by defining the electrical, mechanical, and procedural specifications.
Physical slot	PS	A unit of time, dependent on the physical layer specification, for allocating bandwidth. PS is designated by 1 OFDM symbol.
PIR	-	Maximum Sustained Traffic Rate (see QoS)
Privacy key Management Protocol	PKM	A client/server model between base station and subscriber that is used to secure distribution of keying material.
Protocol Data Unit	PDU	The data unit exchanged between peer entities of the same protocol layer. On the downward direction, it is the data unit generated for the next lower layer. On the upward direction, it is the data unit received from the previous lower layer. MPDU is the data unit exchanged between peer 802.16 MAC entities. One MPDU is formed from one or more SDUs.
Provisioned Service Flow	-	A Service Flow that has been provisioned as part of the Registration process, but has not yet been activated or admitted. It may still require an authorization exchange with a policy module or external policy server prior to admission.
Public Key Infrastructure	PKI	A framework for creating a secure method for exchanging information based on public key cryptography.
Quadrature Amplitude Modulation	QAM	Quadrature Amplitude Modulation (QAM) is a method of combining two amplitude-modulated (AM) signals into a single channel, doubling the effective bandwidth. QAM is used with pulse amplitude modulation (PAM) in digital systems, especially in wireless applications. In a QAM signal, there are two carriers, each having the same frequency but differing in phase by 90 degrees. One signal is called the I signal, and the other is called the Q signal. Mathematically, one of the signals can be represented by a sine wave, and the other by a cosine wave. The two modulated carriers are combined at the source for transmission. At the destination, the carriers are separated, the data is extracted from each, and then the data is combined into the original modulating information.
Quality of Service	QoS	- Minimum Reserved Traffic Rate (CIR) - Maximum Latency - Maximum Sustained Traffic Rate (PIR) - Traffic Priority
Real-Time Polling Service	rt-PS	The rt-PS is intended to support real-time service flows that generate variable size data packets on a periodic basis, such as moving pictures experts group (MPEG) video. The service offers real-time, periodic, unicast request opportunities, which meet the flow's real-time needs and allow the Subscriber to specify the size of the desired grant. This service requires more request overhead than UGS, but supports variable size grants for optimum data transport efficiency.
Receiver Sensitivity	-	A measurement of the weakest signal a receiver can receive and still correctly translate it into data.
RSSI	RSSI	Received signal strength indicator.

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Term	Acronym	Definition
Scope	-	A group of network entities administered by a DHCP Server via its configuration file that get IP addresses in the same subnet. A scope can define common and individual properties for all network entities getting an IP address from that subnet.
Security Association	SA	The set of security information base station and one or more of its client subscribers share in order to support secure communications. This shared information includes traffic encryption keys and cipher block chaining initialization vectors.
Security Association Identifier	SAID	An identifier shared between base station and subscriber that uniquely identifies a security association.
Service Class	-	Service classes are identifiers for a specific set of QoS parameter set values. The use of service classes is optional. A service identified by a service class is identical to a service that has the same QoS parameter set explicitly specified. The Service Class allows operators to configure service flows directly on the RedMAX base station. Operators provision the Subscribers with the Service Class Name; the implementation of the name is configured at the RedMAX base station. This allows operators to modify the implementation of a given service to local circumstances without changing Subscriber provisioning. This feature allows higher layer protocols to create a service flow by its Service Class Name. For example, telephony signaling may direct the subscriber to instantiate any available Provisioned service flow of class G711.
Service Data Unit	SDU	The data unit exchanged between two adjacent protocol layers. On the downward direction, it is the data unit received from the previous higher layer. On the upward direction, it is the data unit sent to the next higher layer.
Service Flow		Service flows are a key feature of the 802.16 standard. A service flow represents a unidirectional data flow. Transmitting bidirectional traffic requires that two service flows be defined: one for the uplink, and another for the downlink. Each service flow can be assigned a unique QoS settings.
Service Flow Identifier	SFID	A 32-bit quantity that uniquely identifies a service flow to both the subscriber and base station.
Service Flow Name	-	An ASCII string that is used to reference a set of QoS settings that (partially) define a service flow.
Service Level Agreement	SLA	This describes in general the minimum quality of service the provider is committed to provide
Simple Network Management Protocol	SNMP	A network management protocol of the IETF.
SINADR	-	Signal to noise and distortion ratio.
Subscriber	SS	The RedMAX base station terminal configured as customer premises equipment (CPE). 802.16 definition of a Subscriber.
Time division duplex	TDD	A duplex scheme where uplink and downlink transmissions occur at different times but share the same frequency.

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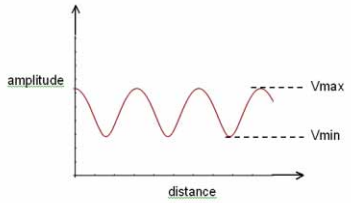
Term	Acronym	Definition
Traffic Encryption Key	TEK	A key used to encrypt and/or decrypt data.
Transmission Control Protocol/Internet Protocol	TCP/IP	The standard set of protocols used by the Internet for transferring information between computers, handsets, and other devices.
Transport Connection		A connection used to transport user data.
Type/ length/ value	TLV	A formatting scheme that adds a tag to each transmitted parameter containing the parameter Type (and implicitly its encoding rules) and the length of the encoded parameter.
Unsolicited Grant Service	UGS	The UGS is designed to support real-time service flows that generate fixed size data packets on a periodic basis, such as TDM and Voice over IP without silence suppression. The service offers fixed size grants on a real-time periodic basis, which eliminate the overhead and latency of Subscriber requests and assure that grants are available to meet the flow's real-time needs.
Uplink		The direction from a subscriber to the RedMAX base station.
Uplink Channel Descriptor	UCD	A UCD message is transmitted by the RedMAX base station at a periodic interval to define the characteristics of an uplink physical channel. A separate UCD message is transmitted for each active uplink channel associated with the downlink channel.
Uplink Interval Usage Code	UIUC	An Interval Usage Code specific to an uplink (to RedMAX base station from subscriber).
Uplink Map:	UL-MAP	A set of information that defines the entire map for the uplink. Based on that, Subscribers send data according to the scheduled opportunities. The UL-MAP is composed from Information Elements.
VSWR	VSWR	Voltage standing wave ratio (VSWR) is the ratio of the amplitude of a partial standing wave at an antinode (maximum) to the amplitude at an adjacent node (minimum). 
Wireless Fidelity	Wi-Fi	Wireless fidelity is used generically when referring of any type of 802.11 network, whether 802.11b, 802.11a, dual-band, etc
WiMAX	WiMAX	Worldwide Interoperability for Microwave Access 802.16 Interop Consortium.
X.509	X.509	X.509 describes two levels of Authentication: simple authentication is based on use of a password to verify user identity, and strong authentication uses credentials created by cryptographic methods.

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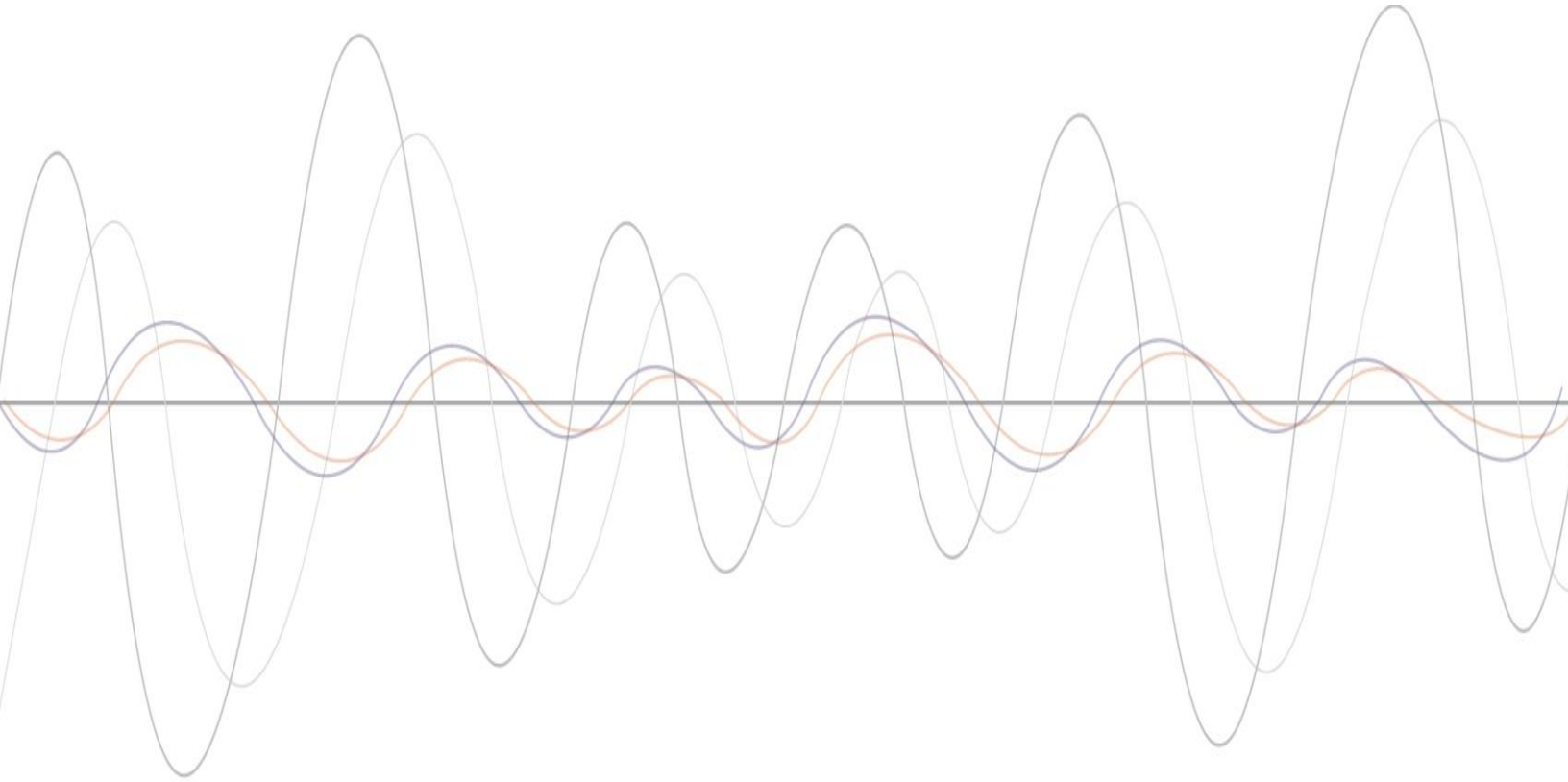

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